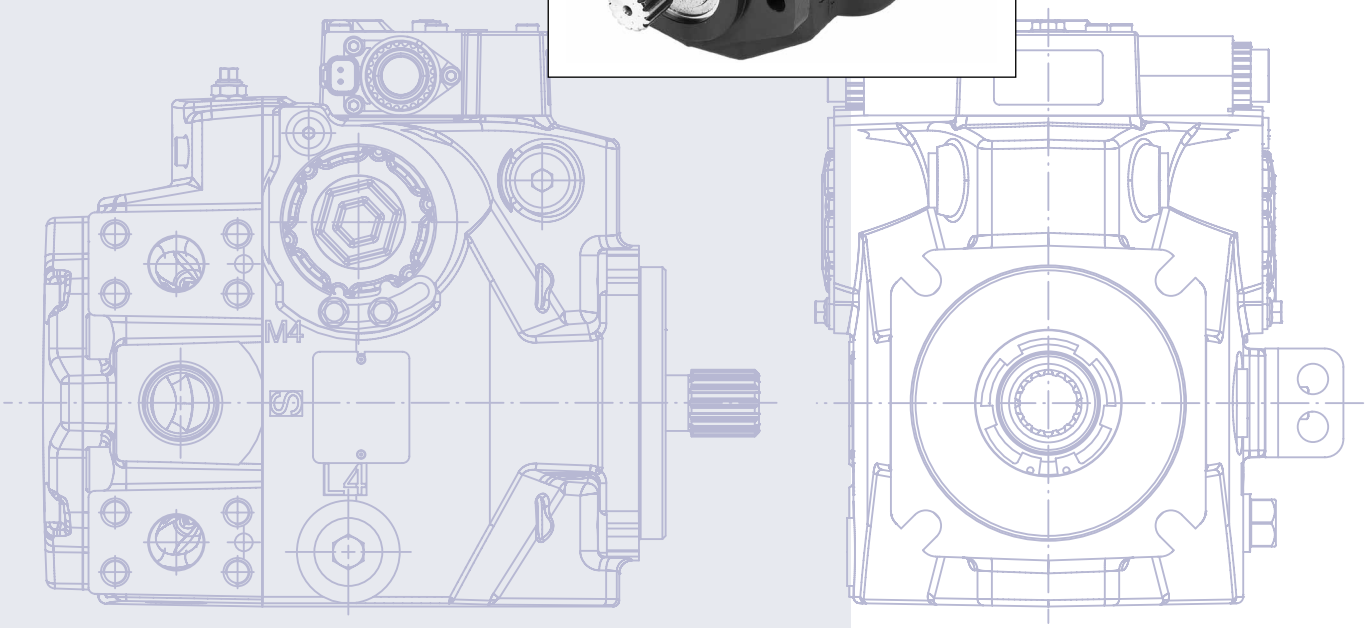
SAUER DANFOSS

H1

Axial Piston Pump
Size 045/053, Single

Technical Information



Revision History

Table of revisions

Date	Page	Changed	Rev
30 Jul, 2009	—	First edition	AA
Feb 2010	various	14 teeth added	BA
Jun, 2010	4-6, 10, 12, 14, 16-17	New EC directive	CA
Feb 2011	Various	Updated drawings	DA
Nov 2012	Various	AC added	EA

Further available literature

Description	SD order number
Overview, H1 Axial Piston Pumps, Single and Tandem	L1012919
Basic Information, H1 Axial Piston Pumps, Single and Tandem	11062168
Technical Information	
H1 Axial Piston Pump, Size 045/053, Single	11063344
H1 Axial Piston Pump, Size 045/053, Tandem	11063345
H1 Axial Piston Pump, Size 060/068, Single	11071685
H1 Axial Piston Pump, Size 069/078, Single	11062169
H1 Axial Piston Pump, Size 089/100, Single	11069970
H1 Axial Piston Pump, Size 115/130, Single	11063346
H1 Axial Piston Pump, Size 147/165, Single	11063347
H1 Automotive Control for Single Axial Piston Pumps 045 - 165 cc	L1223856
Complementary Products	
External Remote Charge Pressure Filter	11064579
Speed and Temperature Sensor	11046759
Pressure Sensor	L1007019
Hydraulic Fluids, Technical Information	
Hydraulic Fluids and Lubricants	520L0463
Experience with Biodegradable Hydraulic Fluids	520L0465
Design Guideline for Hydraulic Fluid Cleanliness	520L0467
Application Information	
Applications Manual, Section 1, Selection of Driveline Components	BLN-9885
Applications Manual, Section 2, Pressure and Speed Limits for Hydraulic Units	BLN-9884
Applications Manual, Section 4, Transmission Circuit Recommendations	BLN-9886
PLUS+1 COMPLIANT (Electrical Installation)	
H1 Electrical Displacement Control (EDC)	11022744
H1 3-position (FNR) Electric Control	11025001
H1 Non-Feedback Proportional Electric (NFPE) Control	11025002
Service Manuals	
H1 Axial Piston Pump, Size 045/053, Single	520L0958
H1 Axial Piston Pump, Size 045/053, Tandem	520L0928
H1 Axial Piston Pump, Size 069/078/089/100/115/130/147/165, Single	520L0848

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Front cover illustrations: F301 557, P003 515

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Technical Specifications

For definitions of the following specifications, see *Basic Information 11062168, Operating parameters.*

General specifications

Design	Axial piston pump of cradle swashplate design with variable displacement
Direction of rotation	Clockwise, counterclockwise
Pipe connections	Main pressure ports: ISO split flange boss
	Remaining ports: SAE straight thread O-ring boss
Recommended installation position	Pump installation position is discretionary, however the recommended control position is on the top or at the side, with the top position preferred. If the pump is installed with the control at the bottom, flushing flow must be provided through port M14 located on the EDC, FNR and NFPE control. Vertical input shaft installation is acceptable. If input shaft is at the top 1 bar case pressure must be maintained during operation. The housing must always be filled with hydraulic fluid. Recommended mounting for a multiple pump stack is to arrange the highest power flow towards the input source. Consult Sauer-Danfoss for nonconformance to these guidelines.
Auxiliary cavity pressure	Will be inlet pressure with internal charge pump. For reference see operating parameter on next page. Will be case pressure with external charge supply. Please verify mating pump shaft seal capability.

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Technical data

Feature	**Unit**		**Size 045**		**Size 053**	
Displacement	cm^3	[in^3]	45.0	[2.75]	53.8	[3.28]
Flow at rated (continuous) speed	l/min	[US gal/min]	153	[40]	183	[48]
Torque at maximum displacement (theoretical)	N•m/bar	[lbf•in/ 1000psi]	0.72	[437.7]	0.86	[522.03]
Mass moment of inertia of rotating components	kg•m^2	[slug•ft^2]	0.00465	[0.00343]	0.00458	[0.00338]
Mass [weight] dry (without charge pump or auxiliary mounting flange)	kg	[lb]		41.0	[90.0]	
Oil volume	liter	[US gal]		1.3	[0.34]	
Mounting flange	ISO 3019-1 flange 101-2 (SAE B) Special bolt diameter. See *installation drawings*.					
Input shaft outer diameter, splines and tapered shafts	ISO 3019-1, outer dia 22 mm - 4 (SAE B, 13 teeth) ISO 3019-1, outer dia 25 mm - 4 (SAE B-B, 15 teeth) ISO 3019-1, outer dia 32 mm - 4 (SAE-B, 14 teeth) Conical keyed shaft end similar to ISO 3019-1 code 25-3, taper 1:8					
Auxiliary mounting flange with metric fasteners, shaft outer diameter and splines	ISO 3019-1, flange 82 - 2, outer dia 16 mm - 4 (SAE A, 9 teeth) ISO 3019-1, flange 82 - 2, outer dia 19 mm - 4 (SAE A, 11 teeth) ISO 3019-1, flange 101 - 2, outer dia 22 mm - 4 (SAE B, 13 teeth) ISO 3019-1, flange 101 - 2, outer dia 25 mm - 4 (SAE B-B, 15 teeth)					
Suction ports	ISO 11926-1 – 1 $^5/_{16}$ -12 (SAE O-ring boss)					
Main port configuration	∅19.0 - 450 bar split flange boss per ISO 6162, M10x1.5 ISO 11926-1 – 1 $^5/_{16}$ -12 (SAE O-ring boss)					
Case drain ports L1, L2	ISO 11926-1 – 1 $^1/_{16}$ -12 (SAE O-ring boss)					
Other ports	SAE O-ring boss. See *installation drawings at the back of this manual.*					
Customer interface threads	Metric fasteners					

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Technical Specifications (continued)

For definitions of the following specifications, see *Basic Information 11062168, Operating parameters.*

Operating parameters

Feature		Unit	Size 045	Size 053
Input speed	Minimum for **internal** charge supply at minimum charge pressure. Performance (pressure and displacement) may be limited due to limited control pressure	min^{-1} (rpm)	500	
	Minimum for **external** charge supply at minimum charge pressure. Full performance (pressure and displacement) possible at minimum charge and control pressure supply.		500	
	Minimum for full performance (pressure and displacement) for **internal** charge supply at minimum charge and control pressure		1175	1250
	Rated		3400	
	Maximum		3500	
System pressure	Maximum working pressure	bar [psi]	420 [6090]	380 [5510]
	Maximum pressure		450 [6525]	400 [5800]
	Maximum low loop		45 [650]	
	Minimum low loop pressure		10 [150]	
Charge pressure	Minimum	bar [psi]	16 [232]	
	Maximum		35 [508]	
Control pressure	Minimum (at corner power for EDC and FNR)	bar [psi]	21.5 [312]	
	Minimum (at corner power for NFPE)		24 [348]	
	Maximum		40 [580]	
Charge pump inlet pressure	Rated	bar (absolute) [in Hg vacuum]	0.7 [9]	
	Minimum (cold start)		0.2 [24]	
	Maximum	bar [psi]	4.0 [58]	
Case pressure	Rated	bar [psi]	3.0 [44]	
	Maximum		5.0 [73]	
Lip seal external pressure	Maximum	bar [psi]	0.4 [5.8]	

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Fluid specifications

Feature		Unit		
Viscosity	Intermittent [1]	mm^2/s [SUS]	5	[42]
	Minimum		7	[49]
	Recommended range		12-80	[66-370]
	Maximum		1600	[7500]
Temperature range [2]	Minimum (cold start) [3]	°C [°F]	-40	[-40]
	Recommended range		60-85	[140-185]
	Rated		104	[220]
	Maximum intermittent [1]		115	[240]
Filtration (recommended minimum)	Cleanliness per ISO 4406		22/18/13	
	Efficiency (charge pressure filtration)	β-ratio	$\beta_{15-20} = 75$ ($\beta_{10} \geq 10$)	
	Efficiency (suction and return line filtration)		$\beta_{35-45} = 75$ ($\beta_{10} \geq 2$)	
	Recommended inlet screen mesh size	µm	100 – 125	

[1] Intermittent = Short term t < 1min per incident and not exceeding 2 % of duty cycle based load-life
[2] At the hottest point, normally case drain port
[3] Cold start = Short term t < 3min, p ≤ 50 bar [725 psi], n ≤ 1000 min^{-1}(rpm)

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Shaft Loads

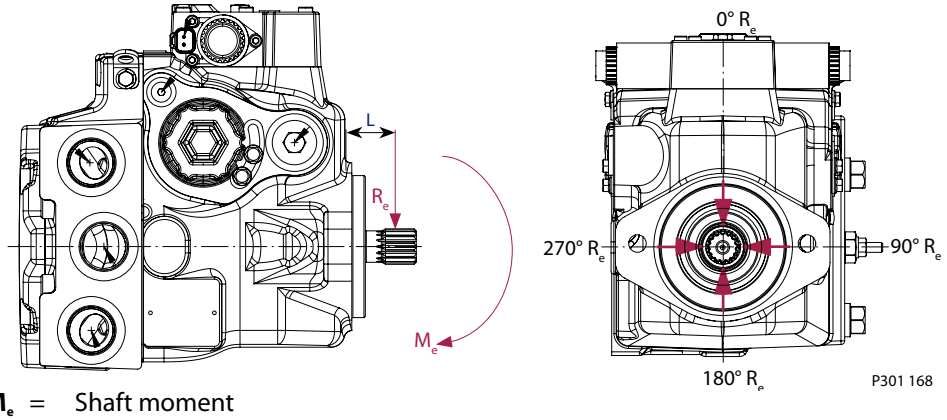
External radial shaft loads

H1 pumps are designed with bearings that can accept some external radial loads. The external radial shaft load limits are a function of the load position and orientation, and the operating conditions of the unit. External radial shaft loads impact lifetime. For lifetime calculations please contact Sauer-Danfoss representative.

The **maximum allowable radial load (R_e)** is based on the maximum external moment (M_e) and the distance (L) from the mounting flange to the load. It may be determined using the following table and formula.

$R_e = M_e / L$

Radial load position



M_e = Shaft moment
L = Flange distance
R_e = External force to the shaft

Thrust loads should be avoided. Contact factory in the event thrust loads are anticipated.

Shaft Loads (continued)

Maximum external shaft load based on shaft deflection

	Unit	Size 045/053
External radial moment – M_e	Nm [lbf•in]	TDB [TBD]

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All external shaft loads affect bearing life. In applications with external shaft loads, minimize the impact by positioning the load at 0° or 180° as shown *in the figure.*

Sauer-Danfoss recommends clamp-type couplings for applications with radial shaft loads.

Contact your Sauer-Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swashplate is positioned on one side of center all or most of the time.

Mounting Flange Loads

H1 single pump front flange load

The moments shown below apply for control orientation top or side (see table and figures).j

Mounting flange load

	Unit	Size 045/053	
		Control orientation	
		Control on top	Control on side
Rated moment – M_R	Nm [lbf•in]	2020 [17 880]	1300 [11 510]
Shock load moment – M_S		4110 [36 380]	2930 [25 935]

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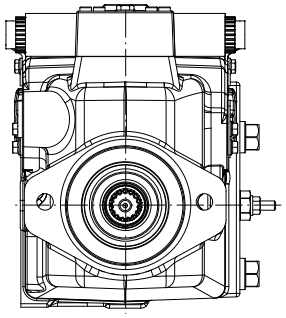
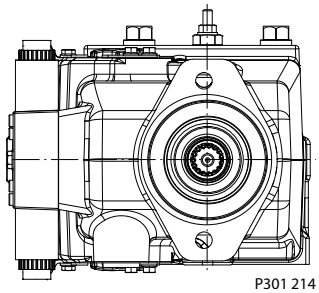
Control on top



Control on side



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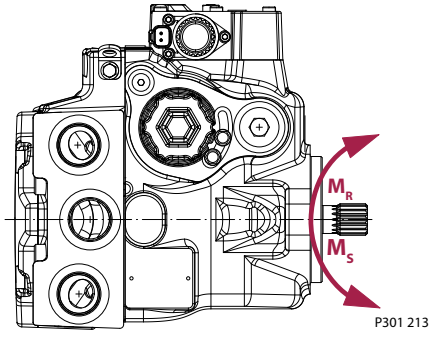
For calculation details refer to *H1 Pump Basic Information Manual 11062168, section Mounting Flange Loads.*



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Model Code

	A	B	D	F	E	G	H	J	K	M	N	S	T	V	W	X	Y
H1 P		A															

Displacement

045	**45** cm^3 [2.75 in^3]
053	**53.8** cm^3 [3.28 in^3]

A Rotation

L	**L**eft hand (counter clockwise)
R	**R**ight hand (clockwise)

B Product Version

A	Revision code

D Control

A2	Electric Displacement Control (EDC) 12V, Deutsch connector
A3	Electric Displacement Control (EDC) 24V, Deutsch connector
A4	Electric Displacement Control (EDC) 12V, Deutsch connector, Manual override
A5	Electric Displacement Control (EDC) 24V, Deutsch connector, Manual override
A9	Forward-Neutral-Reverse (FNR) 12V, Deutsch connector, Manual override
B1	Forward-Neutral-Reverse (FNR) 24V, Deutsch connector, Manual override
A8	Non Feedback Proportional Electric (NFPE) 12V, Deutsch connector, Manual override *(align with option E: Displacement Limiters & option W: Special Hardware)*
B8	Non Feedback Proportional Electric (NFPE) 24V, Deutsch connector, Manual override *(align with option E: Displacement Limiters & option W: Special Hardware)*
A7	AC-1 (Automotive), 12V, Manual Override *(align with option E: Displacement Limiters & option W: Special Hardware)*
C2	AC-1 (Automotive), 24V, Manual Override *(align with option E: Displacement Limiters & option W: Special Hardware)*

F Orifices

C1	Orifices, 0.8 mm in servo supply 1 and 2, recommended for propel applications
C2	Orifices, 1.3 mm in servo supply 1 and 2 (Standard), recommended for propel applications
C3	No orifice, recommended for non-propel applications

E Displacement limiters

N	None
C	No limiters, with nested springs (required for NFPE) *(align with option Y: Settings for adjustment, if applicable)*
B	Adjustable externally *(align with option Y: Settings for adjustment, if applicable)*
D	Adjustable externally with nested springs, required for NFPE

G Endcap options

	Twin port							
High pressure ports	ISO 11 926 O-ring ports				ISO 6162 split flange ports			
Match with below options (M+N)	With pressure limiter		Without pressure limiter (HPRV only)		With pressure limiter		Without pressure limiter (HPRV only)	
Match with below options (T)	Suction filtration	Remote and external charge supply for full charge flow filtration	Suction filtration	Remote or external charge supply for full charge flow filtration	Suction filtration	Remote and external charge supply for full charge flow filtration	Suction filtration	Remote or external charge supply for full charge flow filtration
D6					X			
D8						X		
E5		X						
E6	X							
E9				X				
F1			X					
F2								X
F3							X	

Model Code (continued)

		A	B	D	F	E	G	H	J	K	M	N	S	T	V	W	X	Y
H1 P								F									N N N	N N N

H *Mounting*

F	ISO 3019-1, flange 101-2 (SAE B)

J *Input shaft*

G4	ISO 3019-1, outer dia 22 mm - 4 (SAE B, 13 teeth splined shaft $^{16}/_{32}$ pitch)
G5	ISO 3019-1, outer dia 25 mm - 4 (SAE B-B, 15 teeth splined shaft $^{16}/_{32}$ pitch)
G1	ISO 3019-1, outer dia 32 mm - 4 (SAE B, 14 teeth splined shaft $^{12}/_{24}$ pitch)
F2	Conical keyed shaft end similar to ISO 3019-1 code 25-3, taper 1:8 (key not supplied with pump)

K *Auxiliary mounting pad*

NN	None	
H2	ISO 3019-1, flange 82 - 2, outer dia 16 mm - 4 (SAE A, 9 teeth $^{16}/_{32}$ coupling)	Shipping cover
H1	ISO 3019-1, flange 82 - 2, outer dia 19 mm - 4 (SAE A, 11 teeth $^{16}/_{32}$ coupling)	
H3	ISO 3019-1, flange 101 - 2, outer dia 22 mm - 4 (SAE B, 13 teeth $^{16}/_{32}$ coupling)	
H5	ISO 3019-1, flange 101 - 2, outer dia 25 mm - 4 (SAE B-B, 15 teeth $^{16}/_{32}$ coupling)	

M *Overpressure protection type and setting side "**A**" ***
N *Overpressure protection type and setting side "**B**" ***

*** Pressure protection type must be the same for side "**A**" and "**B**"*

L		High pressure relief valve + pressure limiters with bypass
	K	High pressure relief valve only with bypass (no pressure limiters)
L18	**K18**	180 bar [2610 psi]
L20	**K20**	200 bar [2900 psi]
L23	**K23**	230 bar [3336 psi]
L25	**K25**	250 bar [3630 psi]
L28	**K28**	280 bar [4061 psi]
L30	**K30**	300 bar [4350 psi]
L33	**K33**	330 bar [4786 psi]
L35	**K35**	350 bar [5080 psi]
L38	**K38**	380 bar [5510 psi]
L40	**K40**	400 bar [5800 psi] (45 cm^3 only)
L42	**K42**	420 bar [6090 psi] (45 cm^3 only)

Use the selection for ports "A" and "B"

Contact factory for pressures not shown or for applied pressure above maximum working pressure (*see System Pressure page 5*)

S *Charge pump*

B	12 cm^3/rev [0.73 in^3/rev]
N	No charge pump, external charge supply, (align with Option T: Filtration Options, option E)

T *Filtration options (align with option G: Endcap selection)*

L	Suction filtration *(see basic drawings)*
P	Remote full charge flow filtration *(see endcap drawings)*
E	External charge flow filtation *(see endcap drawings), (align with option S: Charge pump, option N)*

V *Charge pressure relief setting (contact factory for pressure not shown)*

20	20 bar [290 psi]
24	24 bar [348 psi]

W *Special hardware features*

PN	None
P1	NFPE valve plate *(align with option D: Control Selection and option E: Displacement Limiters)*

Model Code (continued)

	A	B	D	F	E	G	H	J	K	M	N	S	T	V	W	X	Y
H1 P							F									N N N	N N N

X *Paint and nametag*

NNN	Black paint and Sauer-Danfoss nametag

Y *Special settings*

NNN	None
D3F	AC1-control, System F: Functional basis, Motor Speed Sensor, CAN J1939 in/out without Customer Files, 12V
D4F	AC1-control, System F: Functional basis, Motor Speed Sensor, CAN J1939 in/out without Customer Files, 24V
D3H	AC1-control, System H: Functional basis, Motor Speed Sensor, CAN J1939 out, SIL2 certifiable without Customer Files, 12V
D4H	AC1-control, System H: Functional basis, Motor Speed Sensor, CAN J1939 out, SIL2 certifiable without Customer Files, 24V

Notes

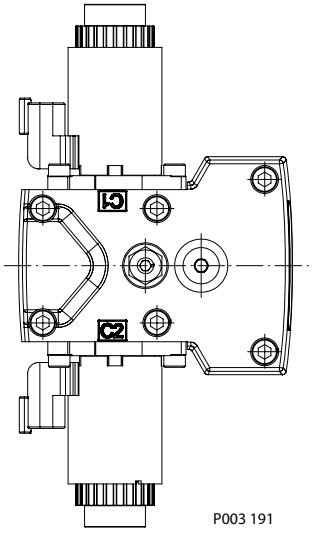
Electrical Displacement Control (EDC) Options A2 (12 V)/A3 (24 V)

EDC Principle

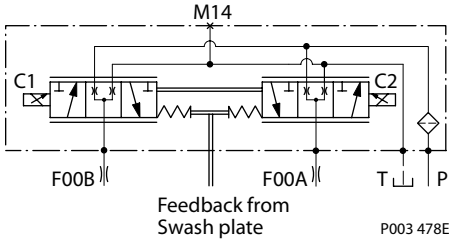
The Electrical Displacement Control (EDC) consists of a pair of proportional solenoids on each side of a three-position, four-way porting spool. The proportional solenoid applies a force input to the spool, which ports hydraulic pressure to either side of a double acting servo piston. Differential pressure across the servo piston rotates the swashplate, changing the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

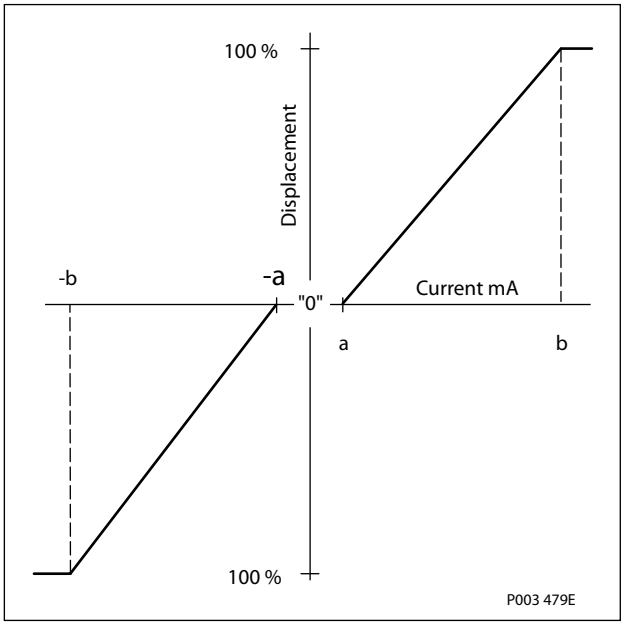
A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.



EDC-Schematic diagram



Pump displacement vs. control current



Control signal requirements

Control current

Voltage	a* mA	b mA	Pin connections
12 V	640	1640	any order
24 V	330	820	

* Factory test current, for vehicle movement or application actuation expect higher or lower value.

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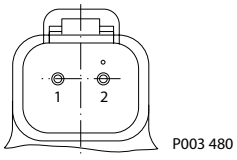
Connector



Description	Quantity	Ordering number
Mating connector	1	Deutsch® DT06-2S
Wedge lock	1	Deutsch® W2S
Socket contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Sauer-Danfoss mating connector kit	1	K29657

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Electrical Displacement Control (EDC) Options A2 (12 V)/A3 (24 V) (continued)

Solenoid data

Voltage	12V	24V
Maximum current	1800 mA	920 mA
Coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (IEC 60 529) + DIN 40 050, part 9	IP 67	
IP Rating (IEC 60 529) + DIN 40 050, part 9 with mating connector	IP 69K	

* PWM signal required for optimum control performance.

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Flow table

Shaft rotation	CW		CCW	
Coil energized*	C2	C1	C2	C1
Port A	in	out	out	in
Port B	out	in	in	out
Servo port pressurized	M5	M4	M5	M4

* For coil location see installation drawings.

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Control response

H1 controls are available with optional control passage orifices to assist in matching the rate of swashplate response to the application requirements (e.g. in the event of electrical failure). Software ramp or rate limiting should be used to control vehicle response in normal operation. The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure. A swashplate response table is available for each frame indicating available swashplate response times. Testing should be conducted to verify the proper software and orifice selection for the desired response.

H1 pumps are limited in mechanical orificing combinations. Software is envisioned as the means to control the swashplate response in normal operating conditions. Mechanical servo orifices are to be used only for fail-safe return to neutral in the event of an electrical failure.

Typical response times shown below at the following conditions:

Δp	=	250 bar	[3626 psi]
Viscosity and temperature	=	30 mm^2/s (50 °C)	[141 SUS (122 °F)]
Charge pressure	=	20 bar	[290 psi]
Speed	=	1800 min^{-1} (rpm)	

Response times

Stroking direction	0.8 mm [0.03 in] Orifice	1.3 mm [0.05 in] Orifice	No orifice
Neutral to full flow	1.7 s	0.9 s	0.5 s
Full flow to neutral	1.1 s	0.6 s	0.3 s

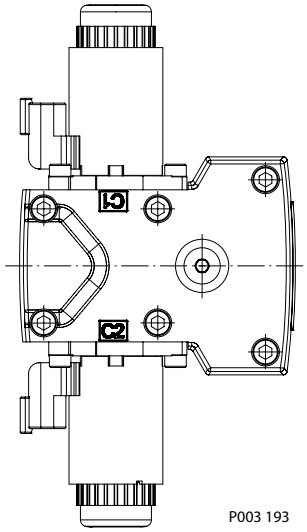
T000 177E

Forward-Neutral-Reverse (FNR) Electric Control Options A9 (12 V)/B1 (24 V)

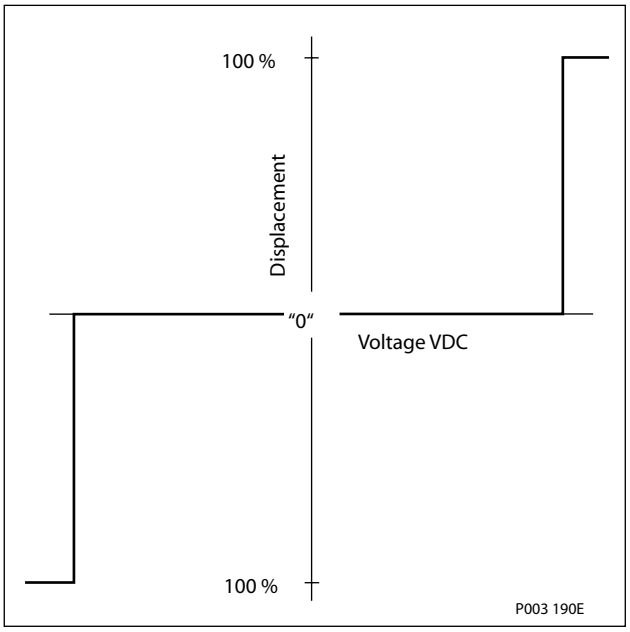
The 3-Position (F-N-R) control uses an electric input signal to switch the pump to a full stroke position.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

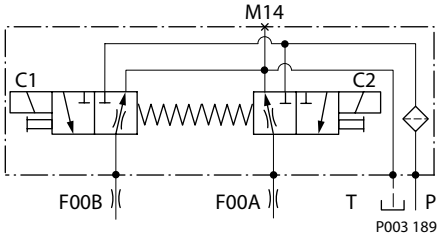
A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.



Pump displacement vs. electrical signal



3-Position electric control, hydraulic schematic

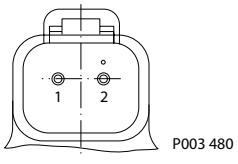


Control current

Voltage	Min. current to stroke pump mA	Pin connections
12 V	750	any order
24 V	380	

T000 138E

Solenoid connector



Description	Quantity	Ordering number
Mating connector	1	Deutsch® DT06-2S
Wedge lock	1	Deutsch® W2S
Socket contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Sauer-Danfoss mating connector kit	1	K29657

T000 134E

Forward-Neutral-Reverse (FNR) Electric Control Options A9 (12 V)/B1 (24 V) (continued)

Solenoid data

Voltage	12 V	24 V
Minimum supply voltage	9.5 Vdc	19.0 Vdc
Maximum supply voltage (continuous)	14.6 Vdc	27.0 Vdc
Maximum current	1050 mA	500 mA
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
IP Rating (IEC 60 529) + DIN 40 050, part 9	IP 67	
IP Rating (IEC 60 529) + DIN 40 050, part 9 with mating connector	IP 69K	

* PWM signal required for optimum control performance.

T000 139E

Pump output flow direction vs. control signal

Shaft rotation	CW		CCW	
Coil energized*	C1	C2	C1	C2
Port A	in	out	out	in
Port B	out	in	in	out
Servo port pressurized	M5	M4	M5	M4

* For coil location see installation drawings.

T000 140E

Control response

H1 controls are available with optional control passage orifices to assist in matching the rate of swashplate response to the application requirements (e.g. in the event of electrical failure). Software ramp or rate limiting should be used to control vehicle response in normal operation. The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure. A swashplate response table is available for each frame indicating available swashplate response times. Testing should be conducted to verify the proper software and orifice selection for the desired response.

H1 pumps are limited in mechanical orificing combinations. Software is envisioned as the means to control the swashplate response in normal operating conditions. Mechanical servo orifices are to be used only for fail-safe return to neutral in the event of an electrical failure.

Typical response times shown below at the following conditions:

Δp	=	250 bar	[3626 psi]
Viscosity and temperature	=	30 mm^2/s (50 °C)	[141 SUS (122 °F)]
Charge pressure	=	20 bar	[290 psi]
Speed	=	1800 min^{-1} (rpm)	

Response times

Stroking direction	0.8 mm [0.03 in] Orifice	1.3 mm [0.05 in] Orifice	No orifice
Neutral to full flow	1.8 s	0.9 s	0.5 s
Full flow to neutral	1.6 s	0.8 s	0.4 s

T000 179E

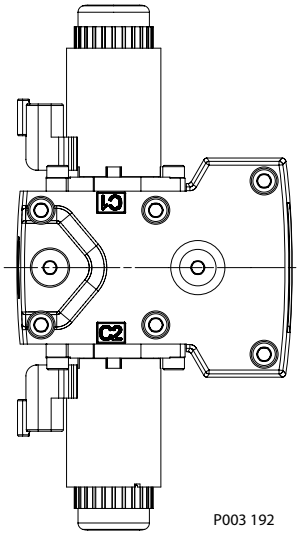
Non Feedback Proportional Electric Control (NFPE) Options A8 (12 V) / B8 (24 V)

The Non Feedback Proportional Electric (NFPE) control is an electrical automotive control in which an electrical input signal activates one of two proportional solenoids that port charge pressure to either side of the pump servo cylinder. The NFPE control has no mechanical feedback mechanism.

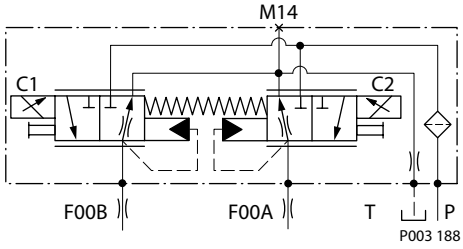
The pump displacement is proportional to the solenoid signal current, but it also depends upon pump input speed and system pressure. This characteristic also provides a power limiting function by reducing the pump swashplate angle as system pressure increases. A typical response characteristic is shown in the accompanying graph.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

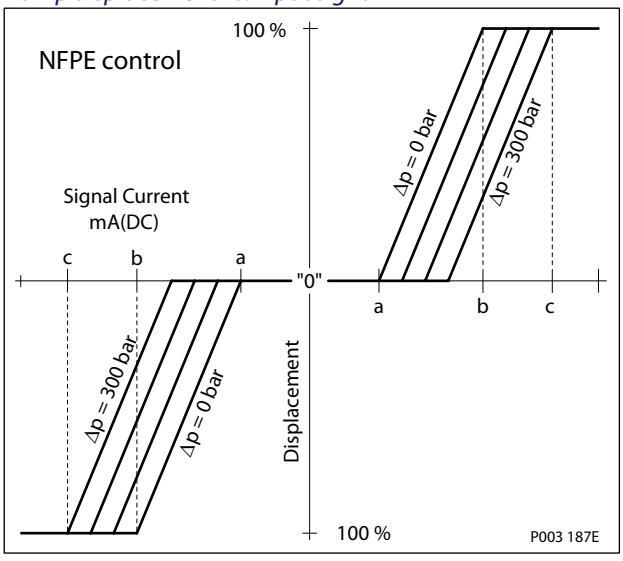
A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.



NFPE Schematic



Pump displacement vs. input signal



Control signal requirements

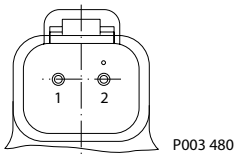
Control current

Size (cm³)	Voltage	a* mA	b mA	c mA	Pin connections
45	12 V	710	1135	1380	any order
	24 V	360	585	675	
53	12 V	715	1140	1495	
	24 V	365	570	720	

* Factory test current, for vehicle movement or application actuation expect higher or lower value.

T301 002E

Connector



Description	Quantity	Ordering number
Mating connector	1	Deutsch® DT06-2S
Wedge lock	1	Deutsch® W2S
Socket contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Sauer-Danfoss mating connector kit	1	K29657

T000 134E

Non Feedback Proportional Electric Control (NFPE) Options A8 (12 V) / B8 (24 V) (continued)

Solenoid data

Voltage	12V	24V
Maximum current	1800 mA	920 mA
Coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (IEC 60 529) + DIN 40 050, part 9	IP 67	
IP Rating (IEC 60 529) + DIN 40 050, part 9 with mating connector	IP 69K	

* PWM signal required for optimum control performance.

T000 135E

Pump output flow direction vs. control signal

Shaft rotation	CW		CCW	
Coil energized*	C1	C2	C1	C2
Port A	in	out	out	in
Port B	out	in	in	out
Servo port pressurized	M5	M4	M5	M4

* For coil location see installation drawings.

T000 140E

Control response

H1 controls are available with optional control passage orifices to assist in matching the rate of swashplate response to the application requirements (e.g. in the event of electrical failure). Software ramp or rate limiting should be used to control vehicle response in normal operation. The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure. A swashplate response table is available for each frame indicating available swashplate response times. Testing should be conducted to verify the proper software and orifice selection for the desired response.

H1 pumps are limited in mechanical orificing combinations. Software is envisioned as the means to control the swashplate response in normal operating conditions. Mechanical servo orifices are to be used only for fail-safe return to neutral in the event of an electrical failure.

Typical response times shown below at the following conditions:

Δp	=	250 bar	[3626 psi]
Viscosity and temperature	=	30 mm^2/s (50 °C)	[141 SUS (122 °F)]
Charge pressure	=	20 bar	[290 psi]
Speed	=	1800 min^{-1} (rpm)	

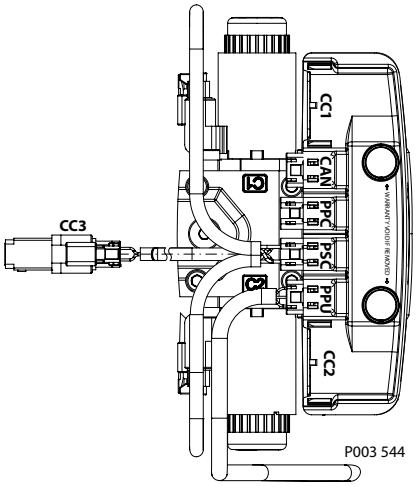
Response times

Stroking direction	0.8 mm [0.03 in] Orifice	1.3 mm [0.05 in] Orifice	No orifice
Neutral to full flow	2.2 s	1.1 s	0.7 s
Full flow to neutral	1.3 s	0.7 s	0.3 s

T301 004E

Automotive Control (AC)

The H1 Automotive Control (H1 AC) is an electric NFPE Control with an integrated Microcontroller, installed on the pump. The integrated Microcontroller enhanced control performance with a flexible, configurable control scheme for an entire single path propel transmission. With the pre-installed application software and easily changeable control parameters, it is possible to tailor the vehicle's driving behavior to the individual requirements of the customer.



The H1 AC Control offers the following features and functions:

Driving Profiles

- Four selectable system modes, selectable via switch.
- Independent curves and settings for forward and reverse (4 x 2 curves).
- Switch selectable between automotive and engine speed independent driving modes.
- Engine speed independent drive modes for sweepers, snow blowers (non-automotive mode).
  - Load independent drive modes for off road applications (non-automotive for rollers and forestry machines).
- Load independent swash plate control via pump swash plate angle sensor to achieve EDC behavior
- Creep speed mode (slow shunting, digging operation, etc.)
- Constant speed mode (sweepers, snow-blowers, etc.)
- Integrated vehicle speed limiter function.

Advanced Control Functions

- Inch function without separate control valve.
- Integrated temperature sensor for:
  - Hydraulic systems overheat protection.
  - Low temperatures pump flow limitation.
  - Compensation of oil viscosity changes if using (radial piston motors, etc.).
  - Configurable engine anti stall protection.
  - Engine over speed protection while inching.

Integrated Motor Controller

- Integrated electric motor control for:
  - Proportional, variable PCOR or two position motor controls.
  - Brake pressure defeat, depending on the FNR position or the real vehicle driving direction.
  - Initial breakaway motor torque override.
- Separate over speed protection for the hydro motor.

Automotive control (AC) (continued)

Auxiliary Functions

- Four auxiliary outputs for :
  - Intelligent brake light control.
  - Automatic park brake function.
  - Vehicle speed dependent output to activate (load stabilizer, warning lights, etc.).
  - Reverse buzzer controlled by FNR or reverse driving.
  - System status lamp (fault detection for pump solenoids).

Economic Features

- Technology and enabler for economic driving and fuel savings.
- Easy combination options to other components of the PLUS+1 Family.

CAN Options

- Engine remote control via CAN J1939.
- Integrated signal converter (analog driving pedal into CAN signal, etc.).
- Compatible to all CAN J1939 components on market (displays, etc.).

Functional Safety

- External Safety Certification for SIL-2 (IEC 61508).
- Safety controlled Vehicle Start-Protection (engine speed check, battery check and FNR must be in neutral, etc.).
- Operator presence detection.
- Vehicle speed dependent direction change lock.
- Brake test mode for roller applications to fulfill EN500-4.

Installation Features

- Factory calibration for hysteresis compensation.
- Starting current adjustment in the factory
- Pre-installed application software and parameter files

Refer to the "Technical Information – H1 Automotive Control" L1223856 for details about installation and wiring.

Manual Over Ride (MOR)

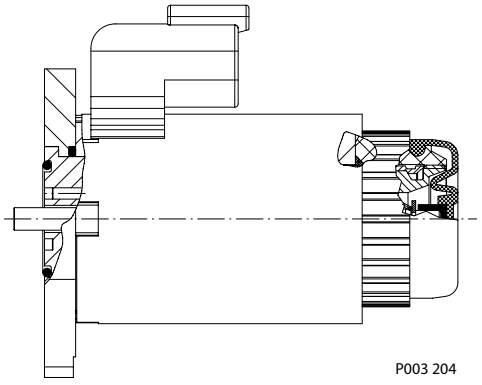
All controls are available with a Manual Over Ride (MOR) either standard or as an option for temporary actuation of the control to aid in diagnostics.
Forward-Neutral-Reverse (FNR) and Non Feedback Proportional Electric (NFPE) controls are always supplied with MOR functionality.

Unintended MOR operation will cause the pump to go into stroke. The vehicle or device must always be in a „safe" condition (i.e. vehicle lifted off the ground) when using the MOR function. The MOR plunger has a 4 mm diameter and must be manually depressed to be engaged. Depressing the plunger mechanically moves the control spool which allows the pump to go on stroke. The MOR should be engaged anticipating a full stroke response from the pump.

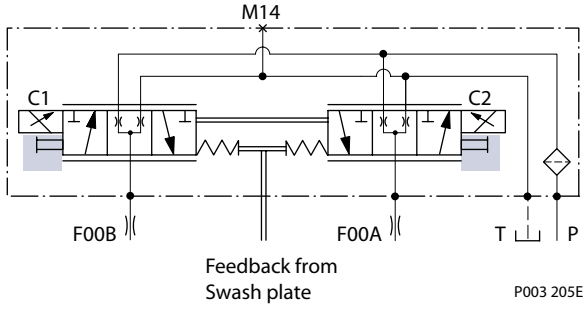
⚠ Warning

An o-ring seal is used to seal the MOR plunger where initial actuation of the function will require a force of 45 N to engage the plunger. Additional actuations typically require less force to engage the MOR plunger. Proportional control of the pump using the MOR should not be expected.

Refer to control flowtable for the relationship of solenoid to direction of flow.



MOR-Schematic diagram (EDC shown)



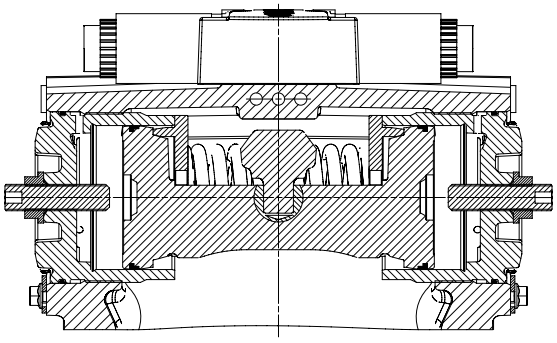
Displacement Limiter

H1 pumps are designed with optional mechanical displacement (stroke) limiters factory set to max. displacement.

The maximum displacement of the pump can be set independently for forward and reverse using the two adjustment screws to mechanically limit the travel of the servo piston down to 50 % displacement. Adjustment procedures are found in the H1 pumps Service Manual.

Adjustments under operating conditions may cause leakage. The adjustment screw can be completely removed from the threaded bore if backed out to far.

Displacement limiter



P003 266

Displacement change (approximately)

Size	1 Turn of displacement limiter screw		Internal wrench size	External wrench size	Torque for external hex seal lock nut	
045	5.1 cm^3	[0.31 in^3]	4 mm	13 mm	23 Nm	[204 lbf•in]
053	6.0 cm^3	[0.37 in^3]				

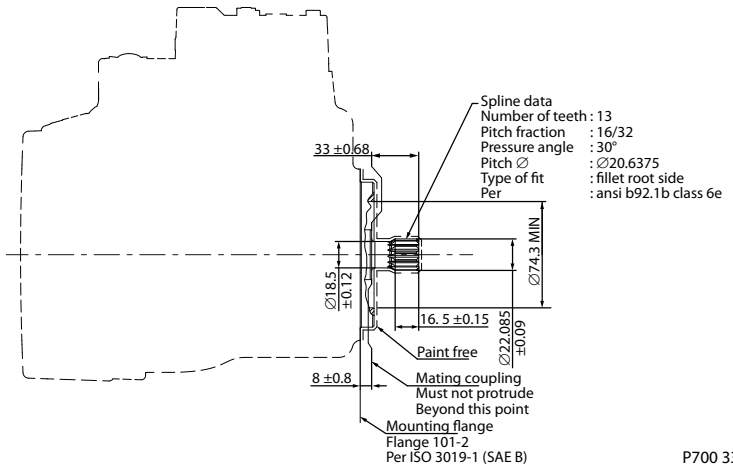
T000 181E

For more information refer to *H1 pumps Service Manual 520L958, section Displacement Limiter Adjustment.*

Input Shafts

Option G4, ISO 3019-1, flange outer dia 22 mm-4 (SAE B, 13 teeth)

mm
[in]



P700 33 266

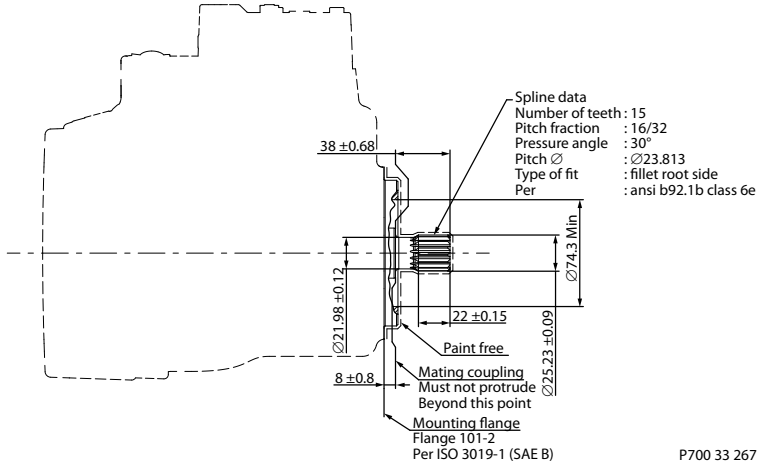
Specifications

Option	Spline	Min active spline length[2]		Torque rating[1]			
				Rated torque		Maximum torque	
		mm	[in]	Nm	[lbf•in]	Nm	[lbf•in]
G4	13 teeth, 16/32 pitch	16.5	[0.65]	180	[1600]	222	[1970]

[1] For definitions of maximum and rated torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.
[2] Minimum active spline length for the specified torque ratings.

T301 005E

Option G5, ISO 3019-1, flange outer dia 25 mm-4 (SAE B-B, 15 teeth)



P700 33 267

Specifications

Option	Spline	Min active spline length[2]		Torque rating[1]			
				Rated torque		Maximum torque	
		mm	[in]	Nm	[lbf•in]	Nm	[lbf•in]
G5	15 teeth, 16/32 pitch	22.0	[0.866]	277	[2450]	370	[3270]

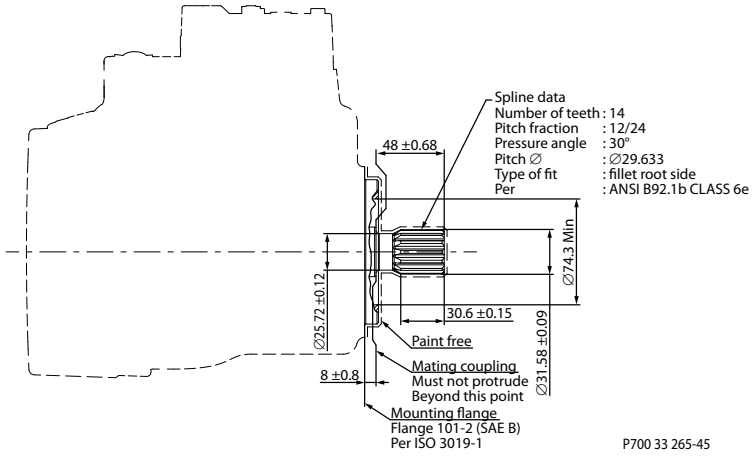
[1] For definitions of maximum and rated torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.
[2] Minimum active spline length for the specified torque ratings.

T000 183E

Input Shafts

Option G1, ISO 3019-1, outer dia 32 mm-4 (SAE B, 14 teeth)

mm
[in]



Specifications

Option	Spline	Min active spline length[2]		Torque rating[1]			
				Rated torque		Maximum torque	
		mm	[in]	Nm	[lbf•in]	Nm	[lbf•in]
G1	14 teeth, 12/24 pitch	30.6	[1.205]	534	[4720]	592	[5240]

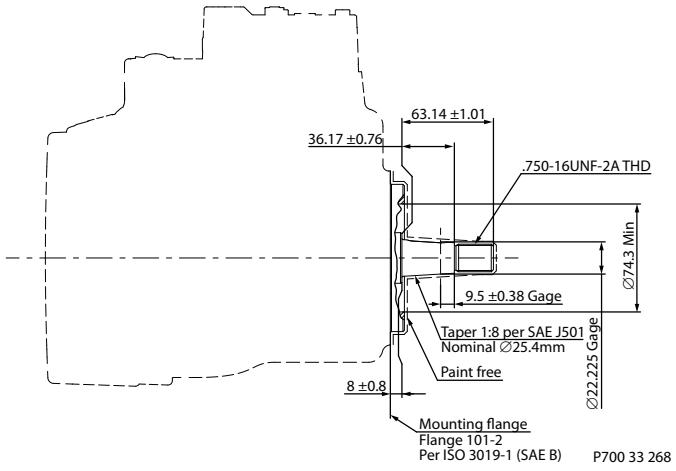
[1] For definitions of maximum and rated torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.
[2] Minimum active spline length for the specified torque ratings.

T000 182E

Input Shafts (continued)

Option F2, ISO 3019-1, Code 25-3, Diameter 25.4 taper 1:8, without key and no through-hole in the end of the shaft

mm
[in]



Specifications

Option	Tapered shaft	Torque rating[1]			
		Rated torque		Maximum torque	
		Nm	[lfb•in]	Nm	[lfb•in]
F2	25.4 taper without key [2]	405	[3580]	540	[4780]

[1] For definitions of maximum torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

[2] Mating part must maintain a minimum gap width of 1.0 mm with the shaft shoulder after installation of the part. Transmittable torque will be reduced if the minimum gap requirement is not met.

T000 190E

Tapered shaft customer acknowledgement

The Sauer-Danfoss H1 tapered shaft has been designed using the industry standard ISO 3019-1, minus the through-hole in the end of the shaft. Sauer-Danfoss recommends a self-locking nut instead of a castle nut and pin. The nut and mating square-cut key are customer supplied.

The specified torque rating of the tapered shaft documented above is based on the cross-sectional diameter of the shaft, through the keyway, and assumes the proper clamp and fit between shaft and coupling. Sauer-Danfoss guarantees the design and manufactured quality of the tapered shaft. The customer is responsible for the design and manufactured quality of the mating female coupling and key and applied torque on the nut.

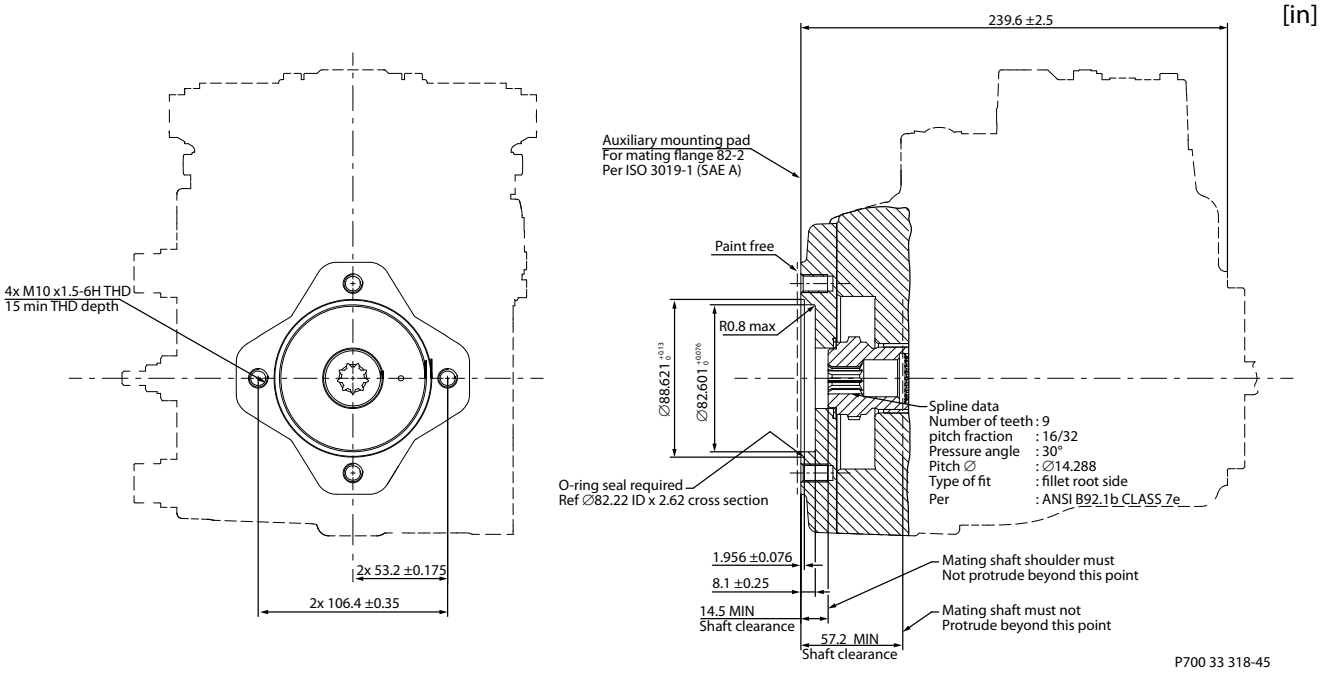
Sauer-Danfoss has made provisions for the key in accordance to the ISO specification with the understanding that the key is solely to assist in the installation of the mating coupling.

Caution

Torque must be transmitted by the taper fit between the shaft and it's mating coupling, not the key. Torque or loading inadvertently transmitted by the customer supplied key may lead to premature shaft failure.

Auxiliary Mounting Pads — Option H2, ISO 3019-1, flange 82-2 (SAE A, 9 teeth)

mm
[in]



Specifications

Option	Spline	Torque rating[1] maximum torque	
		Nm	[lbf•in]
H2	9 teeth, 16/32 pitch	162	[1430]

[1] For definitions of maximum torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

T000 150E

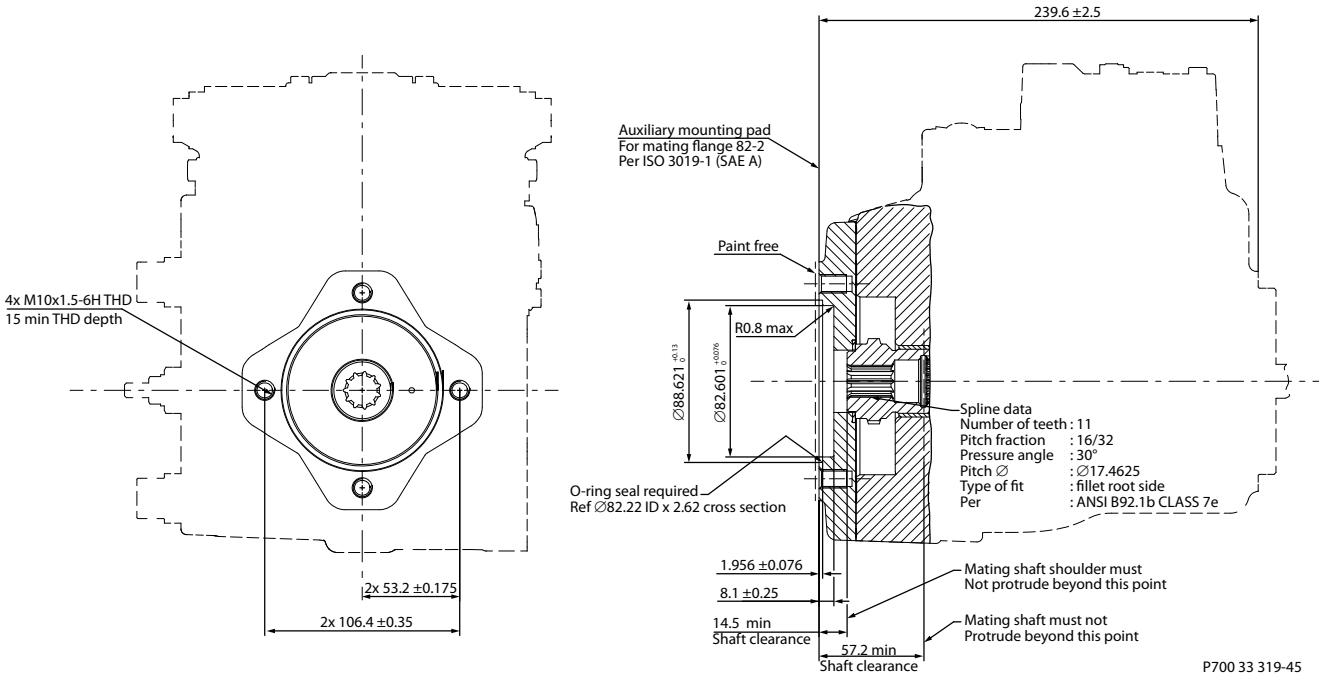
Caution

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Auxiliary Mounting Pads (continued)

Option H1, ISO 3019-1, flange 82-2 (SAE A, 11 teeth)

mm
[in]



Specifications

Option	Spline	Torque rating[1] maximum torque	
		Nm	[lbf•in]
H1	11 teeth, 16/32 pitch	296	[2620]

[1] For definitions of maximum torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

T000 151E

Caution

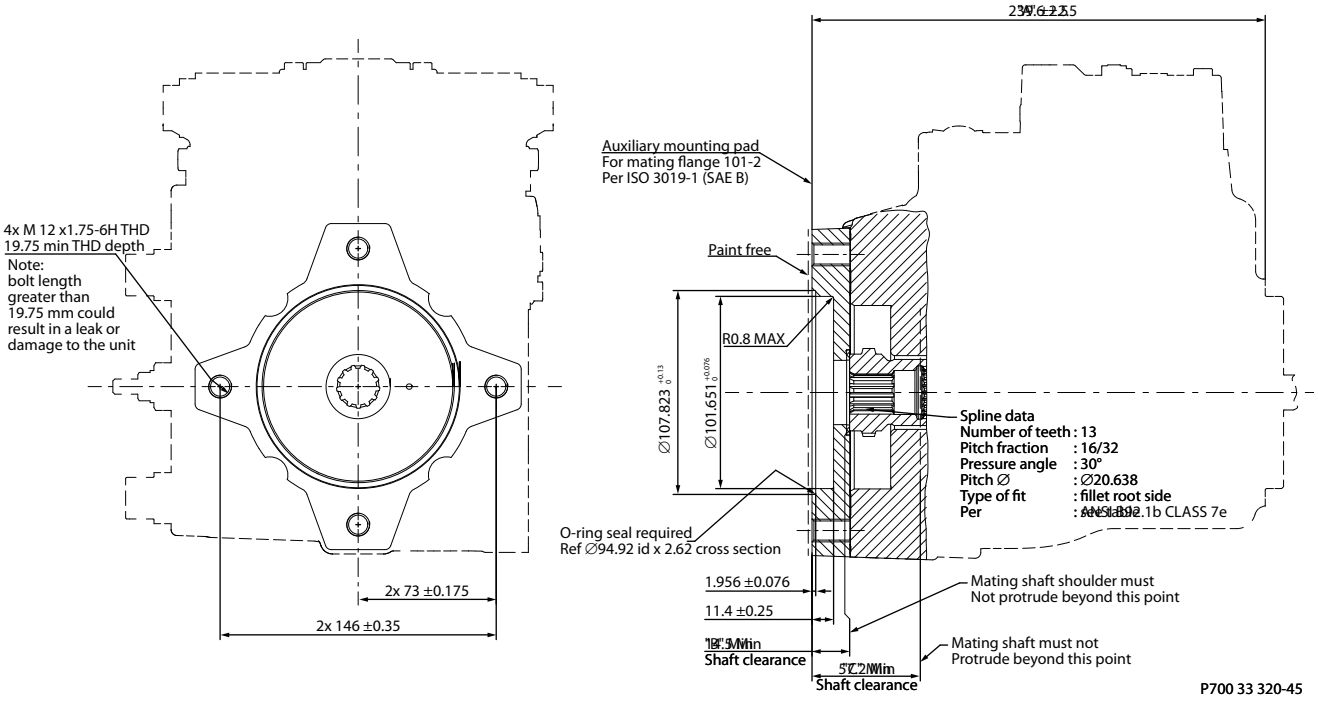
Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Dimensions

Auxiliary Mounting Pads (continued)

Option H3, ISO 3019-1, flange 101-2 (SAE B, 13 teeth)

mm
[in]



Specifications

Option	Spline	Torque rating[1] maximum torque	
		Nm	[lbf·in]
H3	13 teeth, 16/32 pitch	395	[3500]

[1] For definitions of maximum torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

T000 152E

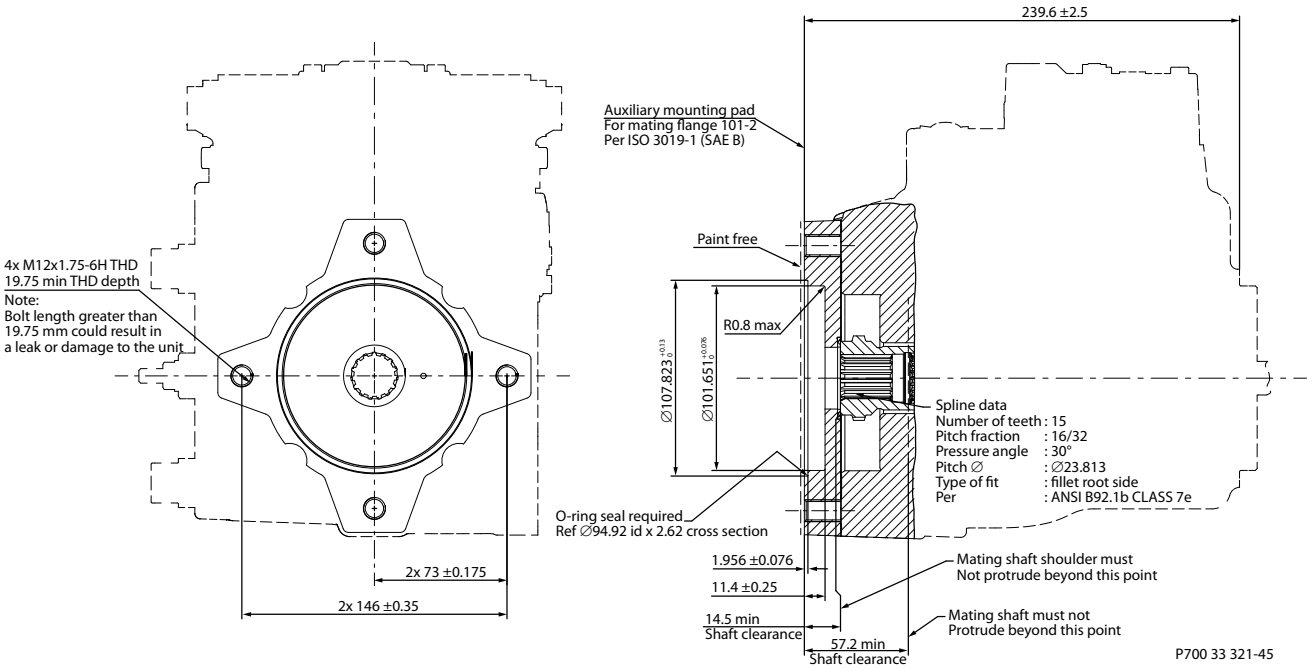
Caution

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Auxiliary Mounting Pads (continued)

Option H5, ISO 3019-1, flange 101-2 (SAE B-B, 15 teeth)

mm
[in]



Specifications

Option	Spline	Torque rating[1] maximum torque	
		Nm	[lbf•in]
H5	15 teeth, 16/32 pitch	405	[3580]

[1] For definitions of maximum torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

T000 212E

Caution

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Charge Pump

Charge pump sizing/selection

In most applications a general guideline is that the charge pump displacement should be at least 10 % of the total displacement of all components in the system. Unusual application conditions may require a more detailed review of charge flow requirements. Please refer to BLN-9885, Selection of Drive line Components, for a detailed procedure.

System features and conditions which may invalidate the 10 % guideline include (but are not limited to):

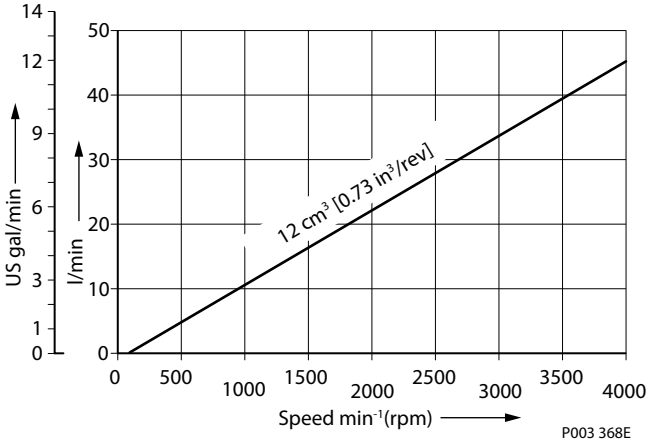
- Continuous operation at low input speeds (< 1500 min^{-1} (rpm))
- High shock loading and/or long loop lines
- High flushing flow requirements
- Multiple Low Speed High Torque motors
- High input shaft speeds

Contact your Sauer-Danfoss representative for application assistance if your application includes any of these conditions.

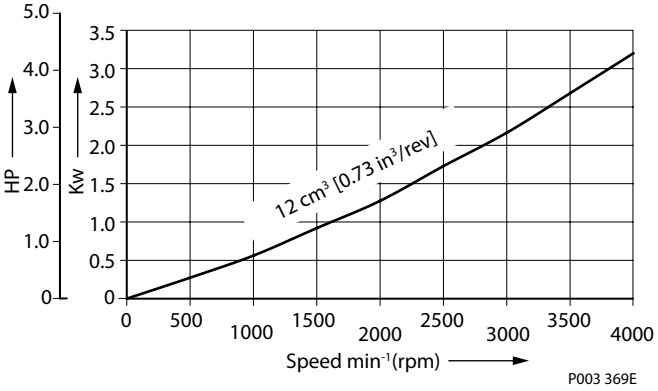
Charge pump flow and power curves

Charge pressure: 20 bar [290 psi]
Viscosity and temperature: 11 mm^2/s [63 SUS] 80 °C [180 °F]

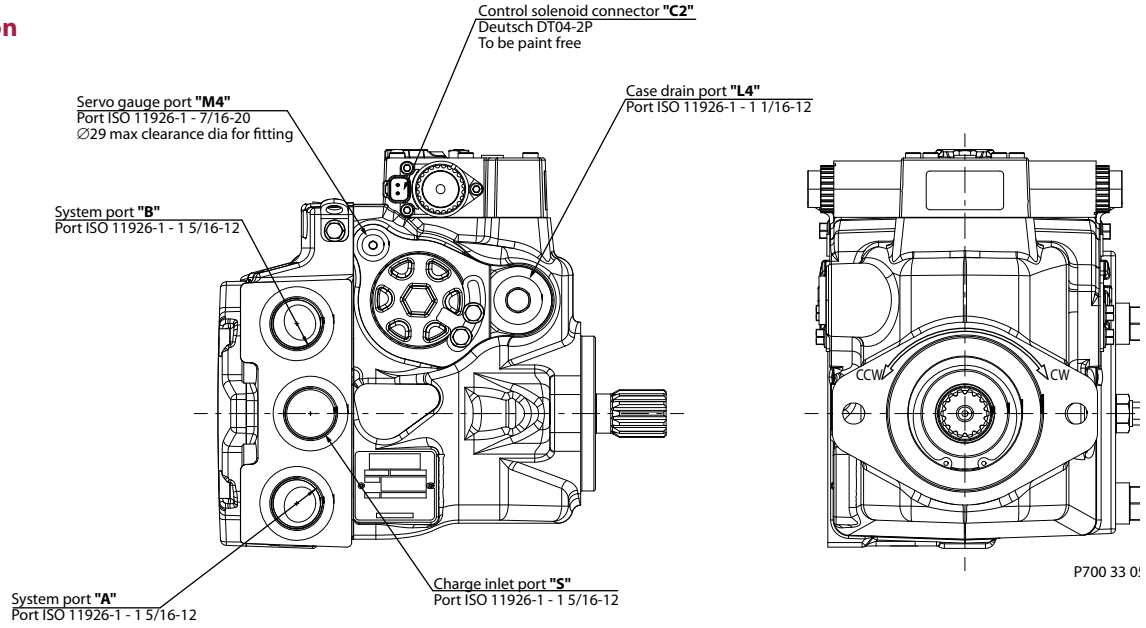
Charge pump flow

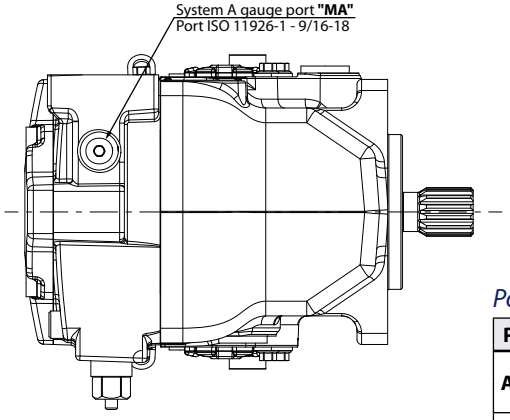


Charge pump power requirements



Port Description


Control solenoid connector **"C2"**
Deutsch DT04-2P
To be paint free
Servo gauge port **"M4"**
Port ISO 11926-1 - 7/16-20
∅29 max clearance dia for fitting
Case drain port **"L4"**
Port ISO 11926-1 - 1 1/16-12
System port **"B"**
Port ISO 11926-1 - 1 5/16-12
CCW
CW
System port **"A"**
Port ISO 11926-1 - 1 5/16-12
Charge inlet port **"S"**
Port ISO 11926-1 - 1 5/16-12
P700 33 0



Port description

Port	Description		Sizes
A	System port "**A**", optional ports	ISO 11 926-1	1 5/16-12
		ISO 6162	∅19.0
B	System port "**B**", optional ports	ISO 11 926-1	1 5/16-12
		ISO 6162	∅19.0
E	Charge filtration port, from filter		7/8-14
F	Charge filtration port, to filter		7/8-14
L1	Case drain port		1 1/16-12
L2	Case drain port		1 1/16-12
MA	System "A" gauge port		9/16-18
MB	System "B" gauge port		9/16-18
M3	Charge gauge port		9/16-18
AM3	Alternate charge pressure port		9/16-18
M4	Servo gauge port		7/16-20
M5	Servo gauge port		7/16-20
M14	Case gauge port		7/16-20
S	Charge inlet port		1 5/16-12

T301 007E

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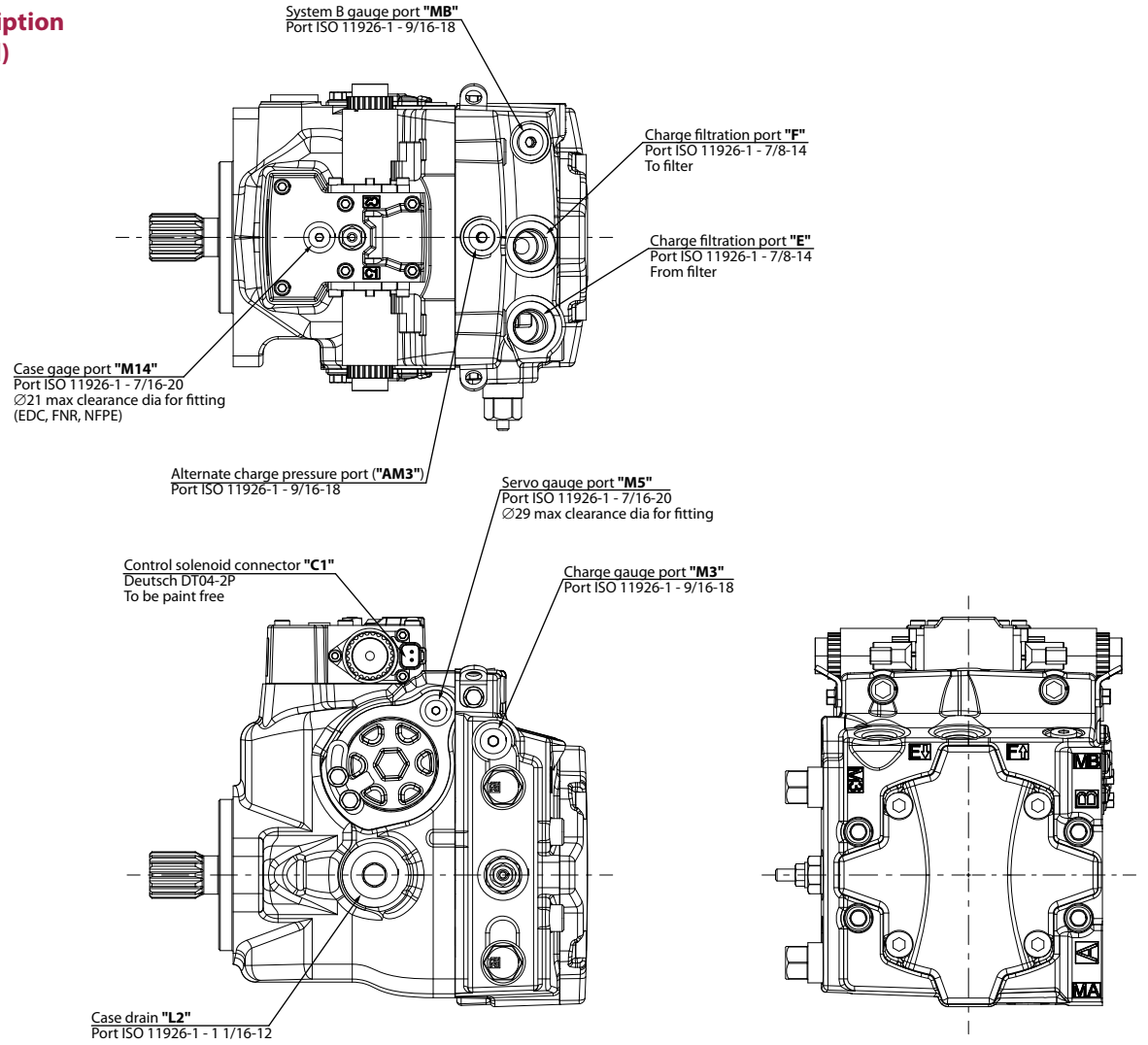
Port Description (continued)

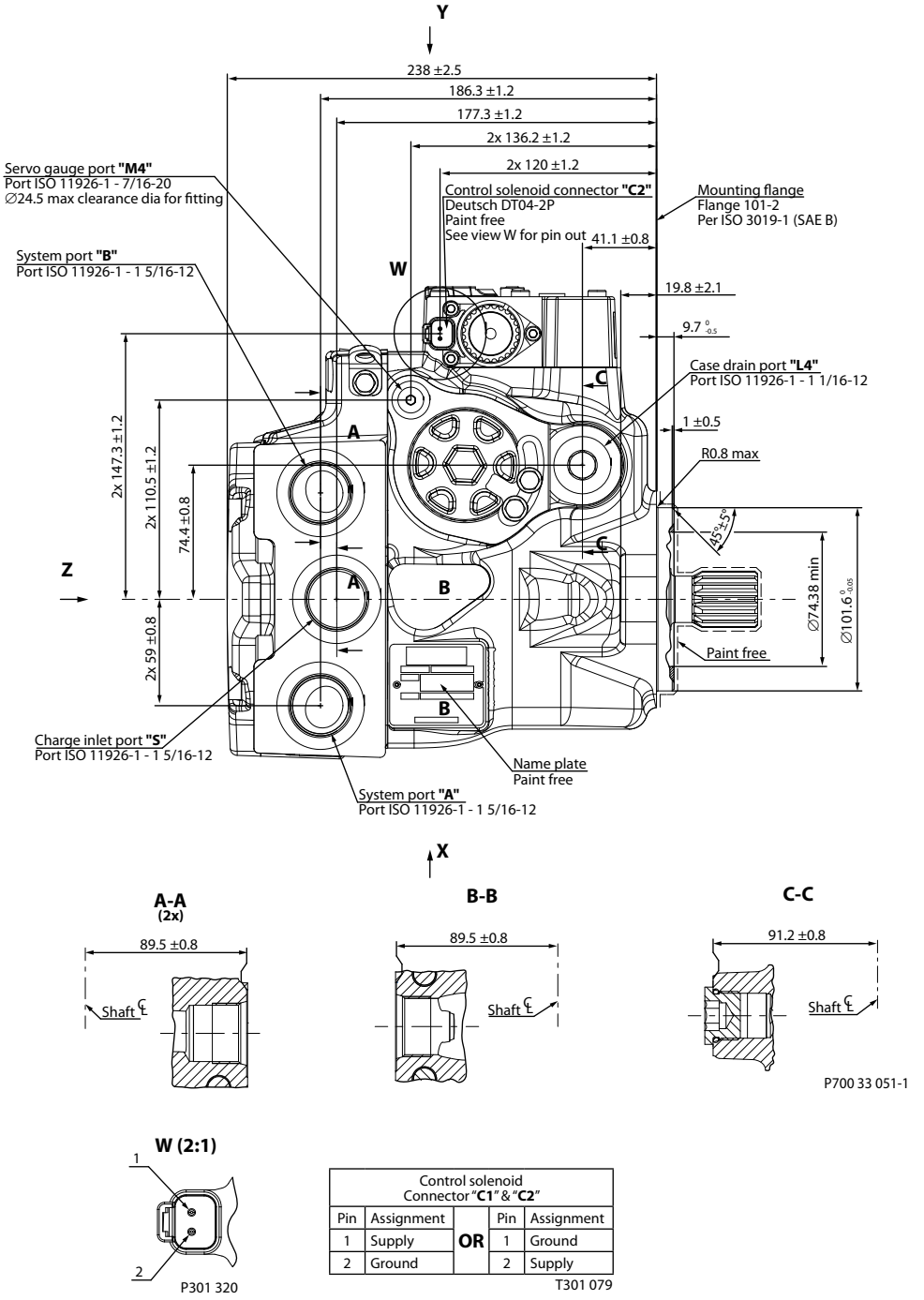


Please contact Sauer-Danfoss for specific installation drawings

Dimensions

Twin port, ORB, remote filter

mm



Control solenoid Connector "**C1**" & "**C2**"				
Pin	Assignment	**OR**	Pin	Assignment
1	Supply		1	Ground
2	Ground		2	Supply

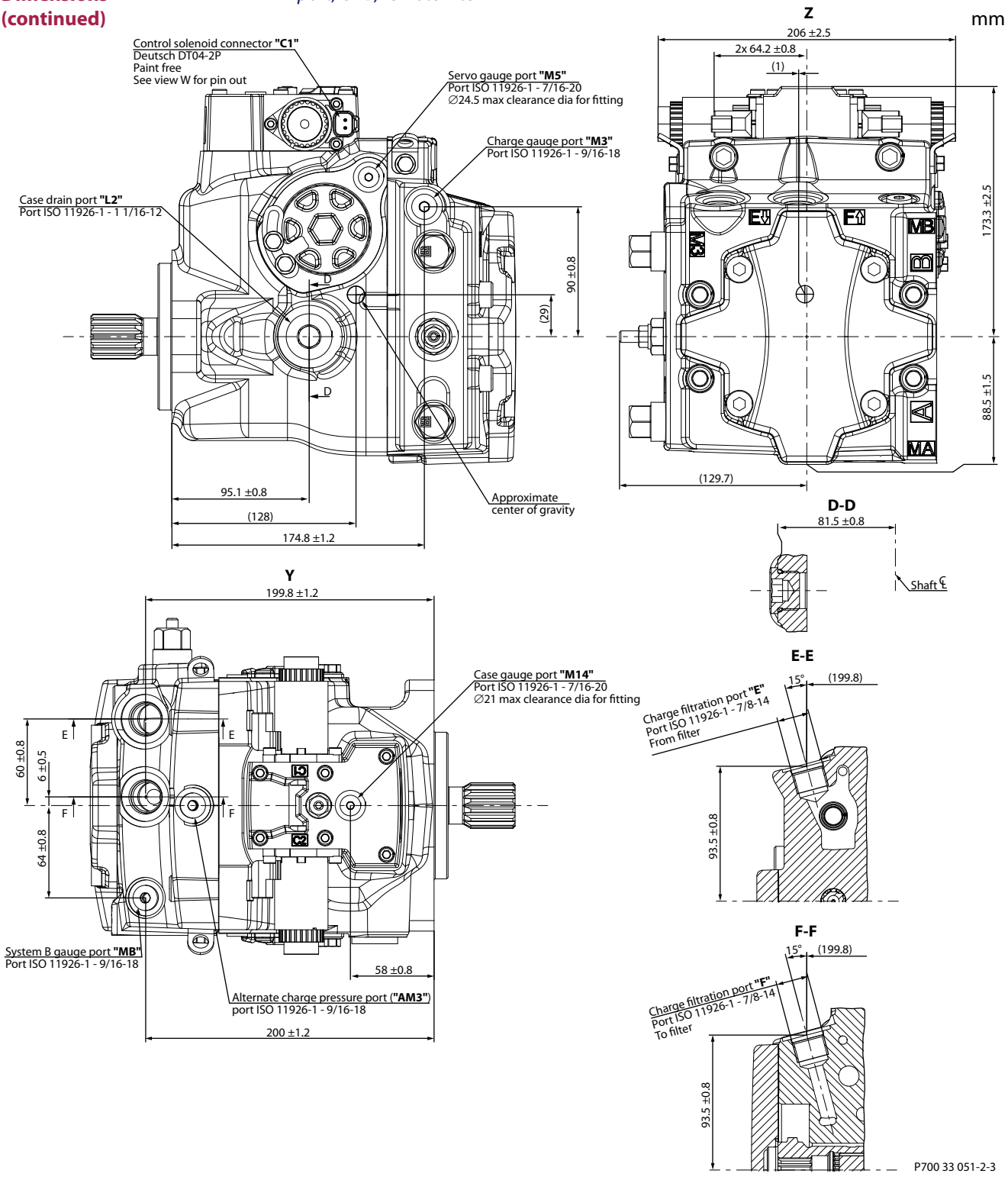
T301 079

Please contact Sauer-Danfoss for specific installation drawings

Dimensions (continued)

Twin port, ORB, remote filter

mm



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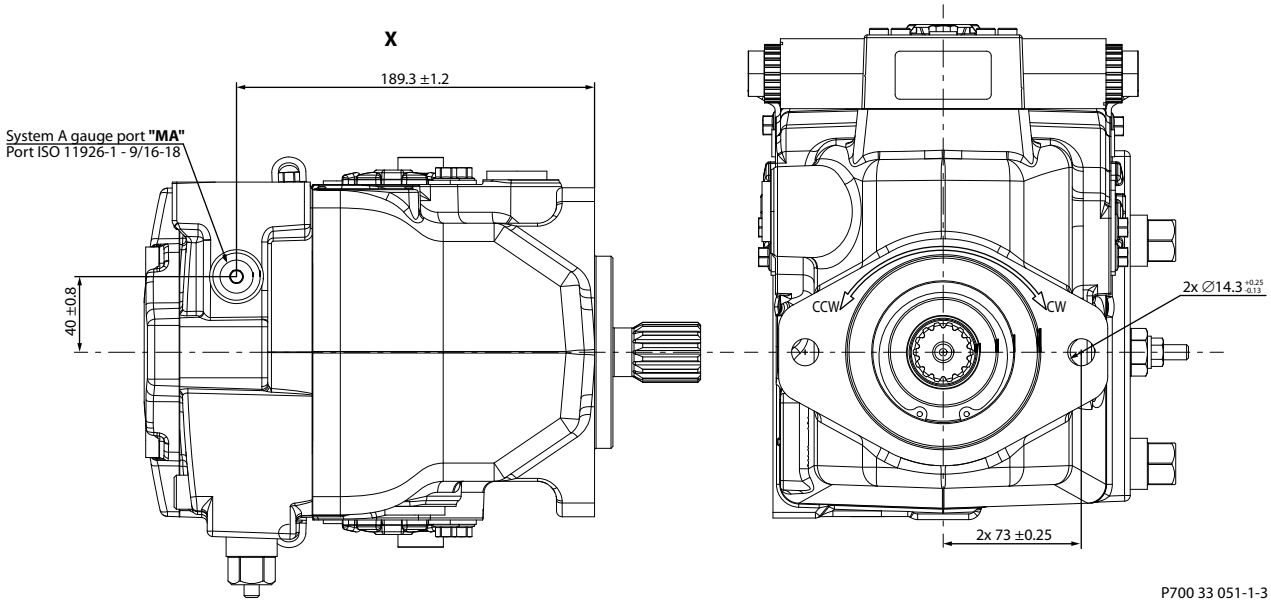
Dimensions (continued)

mm



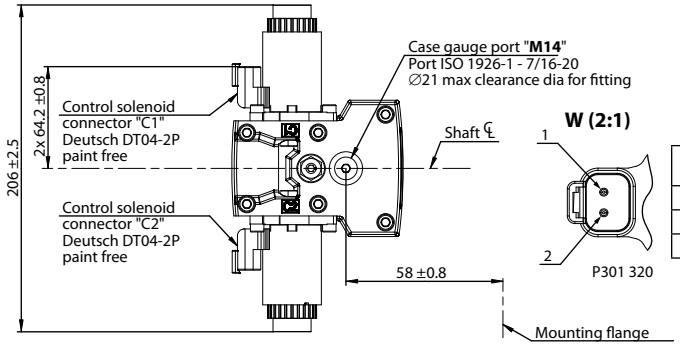
Please contact Sauer-Danfoss for specific installation drawings

Dimensions (continued)

Controls

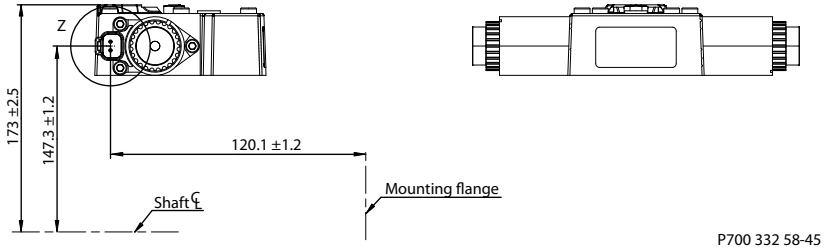
mm

*Electric Displacement Control (EDC), option **A2** (12 V) / **A3** (24 V)*



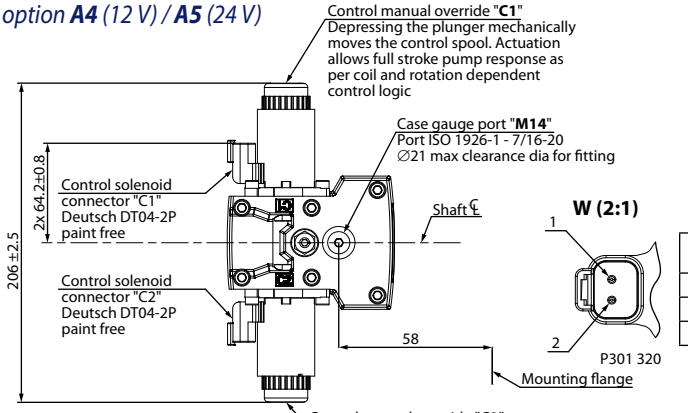
Control solenoid Connector "**C1**" & "**C2**"				
Pin	Assignment	**OR**	Pin	Assignment
1	Supply		1	Ground
2	Ground		2	Supply

T301 079



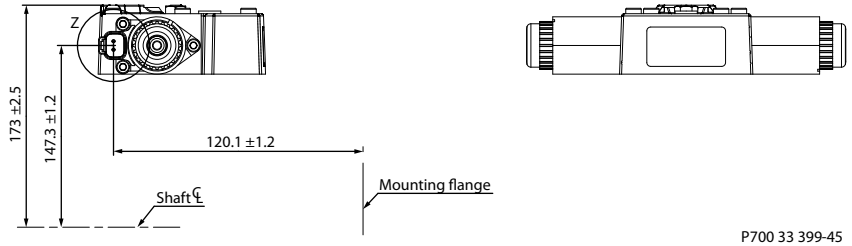
P700 332 58-45

*Electric Displacement Control (EDC) with manual override, option **A4** (12 V) / **A5** (24 V)*


Control manual override "C1"
Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic
Case gauge port "M14"
Port ISO 1926-1 - 7/16-20
∅21 max clearance dia for fitting
Control solenoid connector "C1" Deutsch DT04-2P paint free
Control solenoid connector "C2" Deutsch DT04-2P paint free
2x 64.2±0.8
206 ±2.5
Shaft
58
Mounting flange
W (2:1)
1
2
P301 320
Control manual override "C2"
Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic

Control solenoid Connector "**C1**" & "**C2**"				
Pin	Assignment	**OR**	Pin	Assignment
1	Supply		1	Ground
2	Ground		2	Supply

T301 079



P700 33 399-45

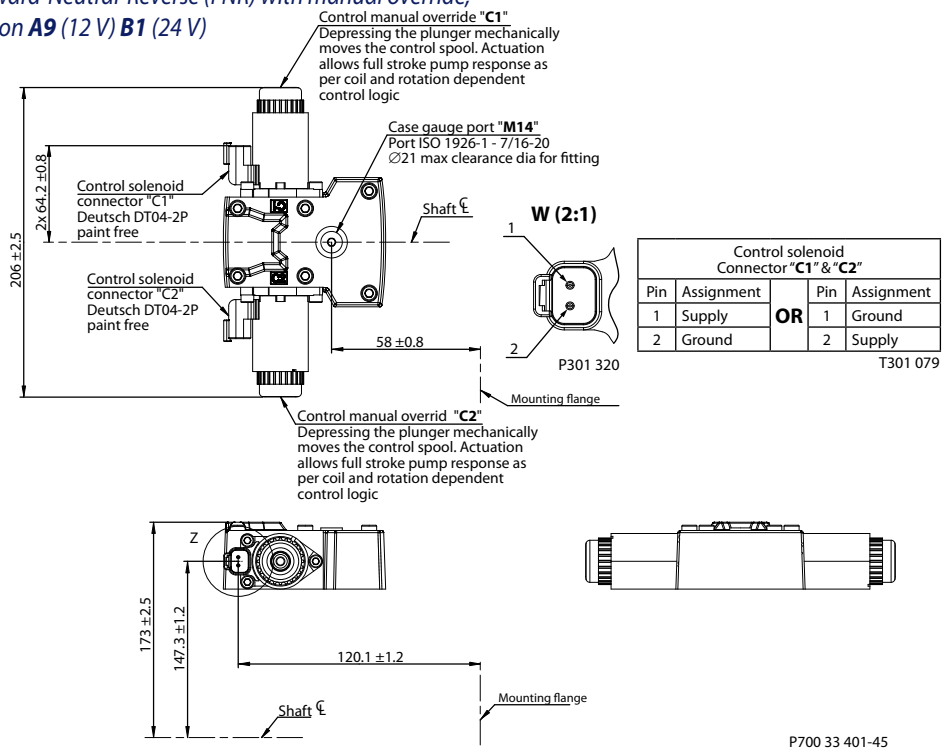
Please contact Sauer-Danfoss for specific installation drawings

Dimensions (continued)

Controls

mm

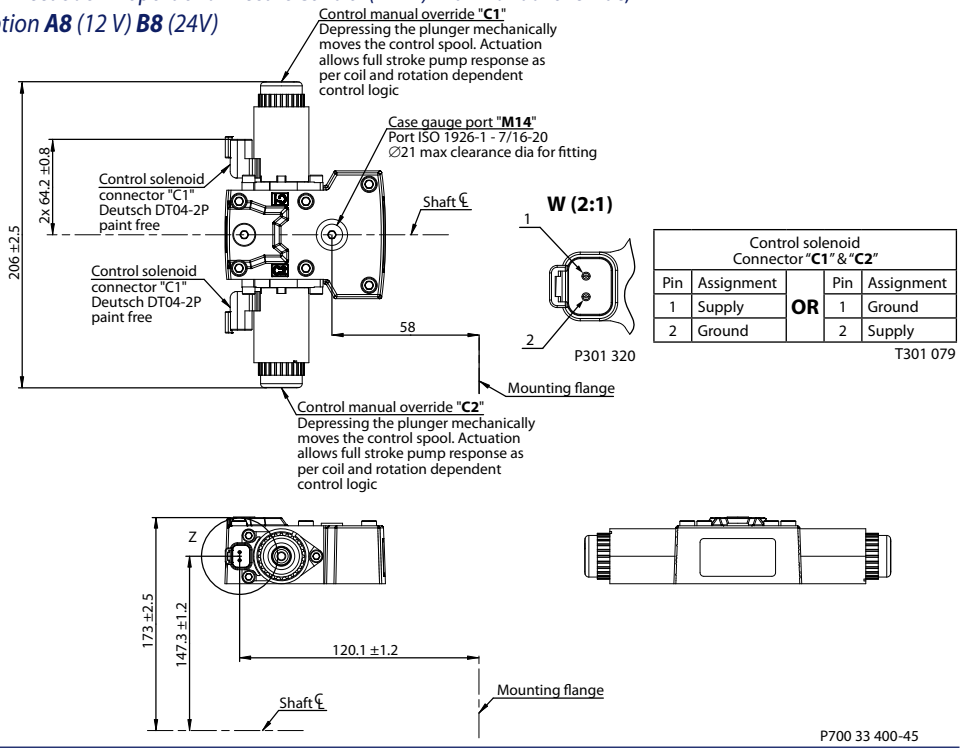
*Forward-Neutral-Reverse (FNR) with manual override, option **A9** (12 V) **B1** (24 V)*


Control manual override "C1"
Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic
Case gauge port "M14"
Port ISO 1926-1 - 7/16-20
∅21 max clearance dia for fitting
Control solenoid connector "C1" Deutsch DT04-2P paint free
Control solenoid connector "C2" Deutsch DT04-2P paint free
2x 64.2 ±0.8
206 ±2.5
Shaft
W (2:1)
1
2
P301 320
58 ±0.8
Mounting flange
Control manual overrid "C2"
Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic
Z
173 ±2.5
147.3 ±1.2
120.1 ±1.2
Shaft
Mounting flange
P700 33 401-45

Control solenoid Connector "C1" & "C2"				
Pin	Assignment	OR	Pin	Assignment
1	Supply		1	Ground
2	Ground		2	Supply

T301 079

*Non Feedback Proportional Electric Control (NFPE) with manual override, option **A8** (12 V) **B8** (24V)*


Control manual override "C1"
Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic
Case gauge port "M14"
Port ISO 1926-1 - 7/16-20
∅21 max clearance dia for fitting
Control solenoid connector "C1" Deutsch DT04-2P paint free
Control solenoid connector "C1" Deutsch DT04-2P paint free
2x 64.2 ±0.8
206 ±2.5
Shaft
W (2:1)
1
2
P301 320
58
Mounting flange
Control manual override "C2"
Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic
Z
173 ±2.5
147.3 ±1.2
120.1 ±1.2
Shaft
Mounting flange
P700 33 400-45

Control solenoid Connector "C1" & "C2"				
Pin	Assignment	OR	Pin	Assignment
1	Supply		1	Ground
2	Ground		2	Supply

T301 079

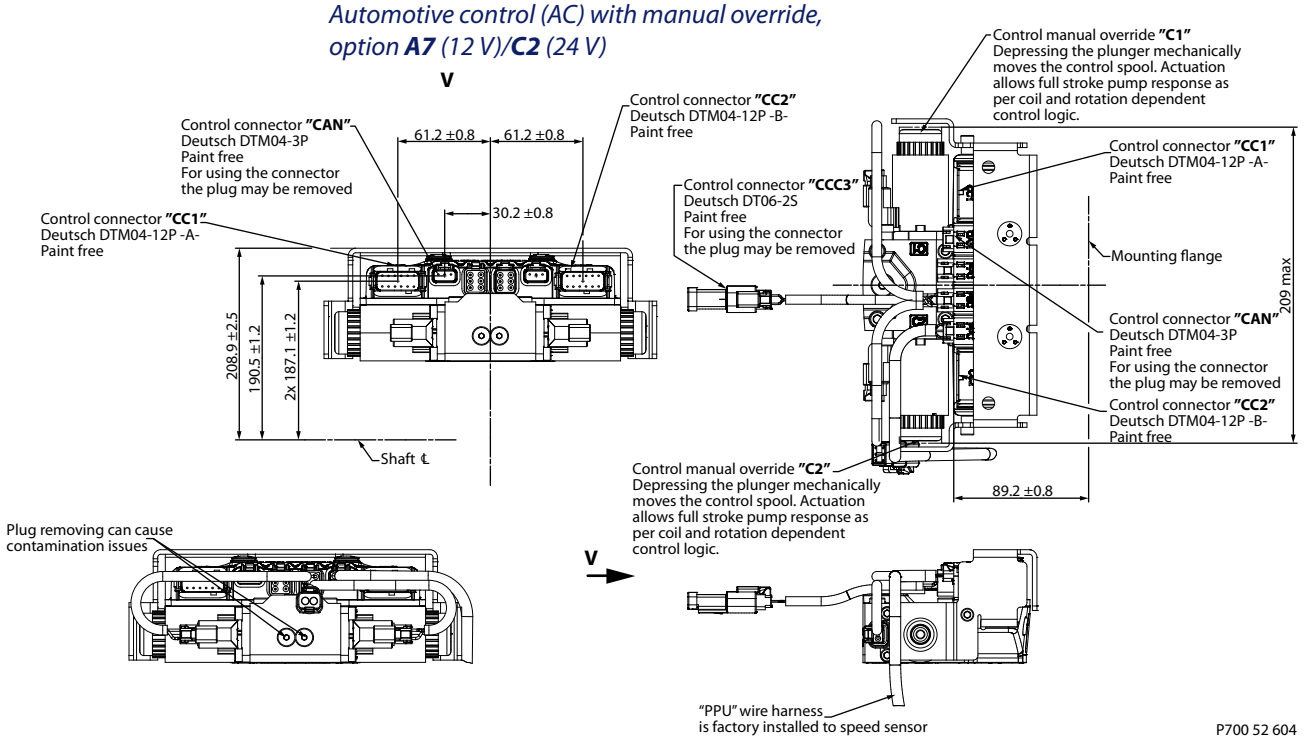
Please contact Sauer-Danfoss for specific installation drawings

Dimensions (continued)

Controls

mm

*Automotive control (AC) with manual override, option **A7** (12 V)/**C2** (24 V)*



P700 52 604

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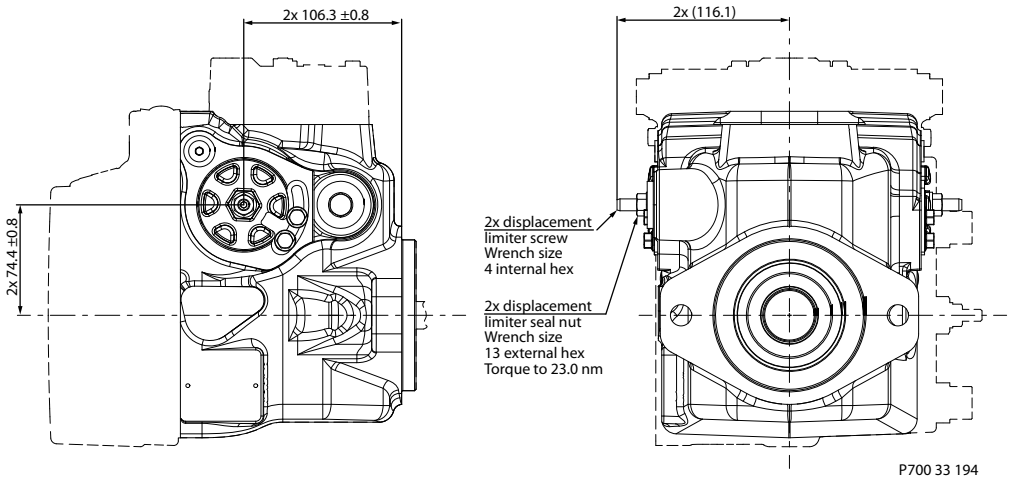
Dimensions (continued)

Displacement limiters

*Displacement limiter, option **B** and **D***

mm


2x 106.3 ±0.8
2x (116.1)
2x 74.4 ±0.8
2x displacement limiter screw Wrench size 4 internal hex
2x displacement limiter seal nut Wrench size 13 external hex Torque to 23.0 nm
P700 33 194

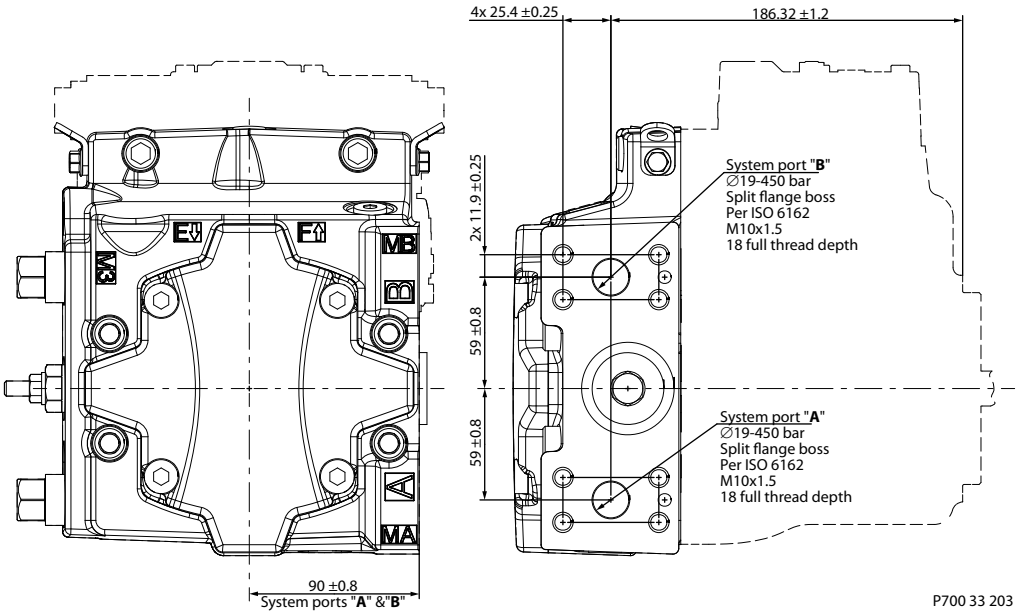
Please contact Sauer-Danfoss for specific installation drawings

Installation Drawings (continued)

Endcap

mm

*Twin port, code 62 metric 4 bold FLG, option **D6, D8, F2,** and **F3***



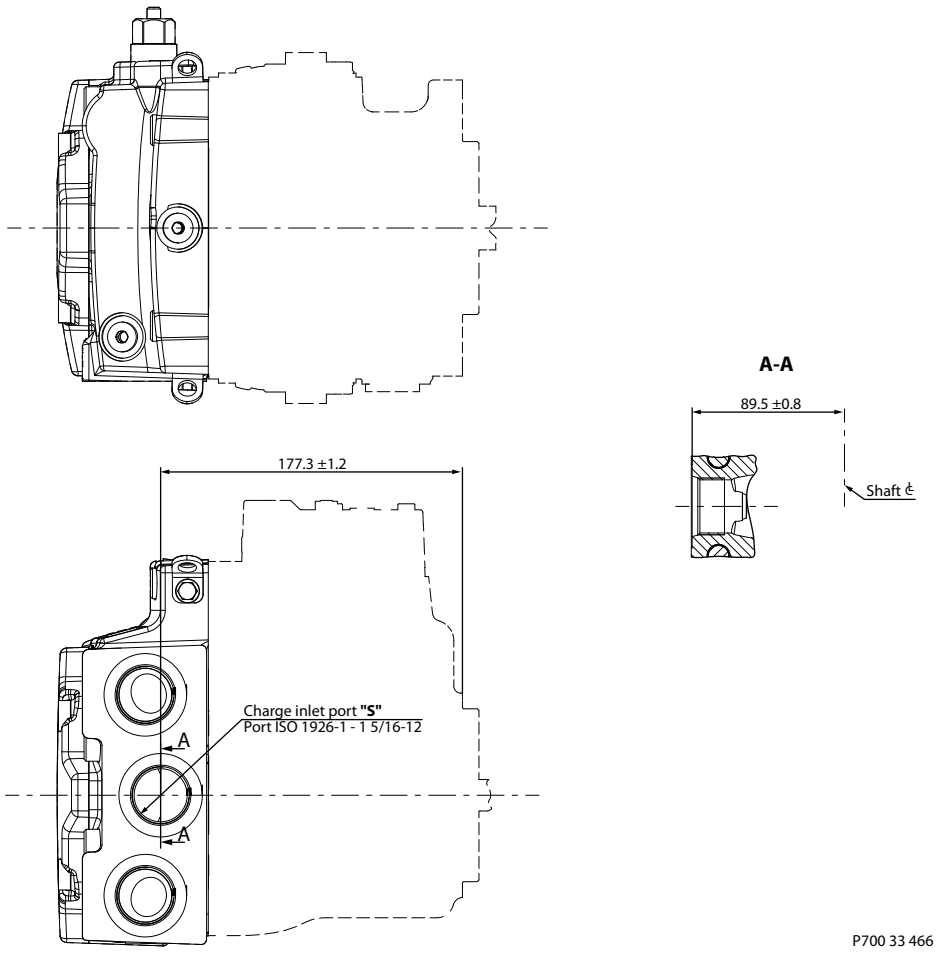
Please contact Sauer-Danfoss for specific installation drawings

Installation Drawings (continued)

Filtration

mm

*Suction filtration, option **L***



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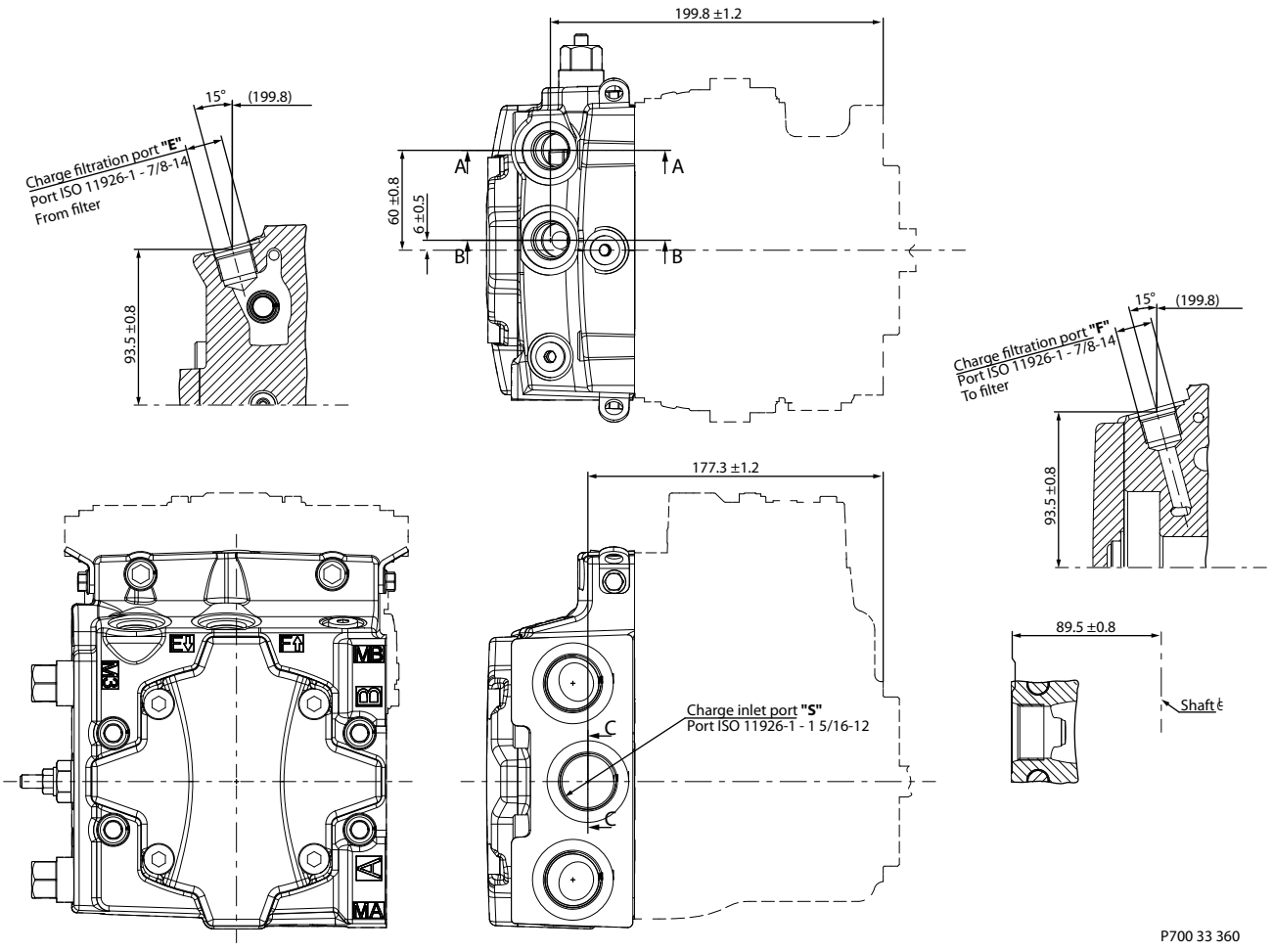
Installation Drawings (continued)

Filtration

mm

*Remote full flow charge pressure filtration, option **P** for end cap option **F***



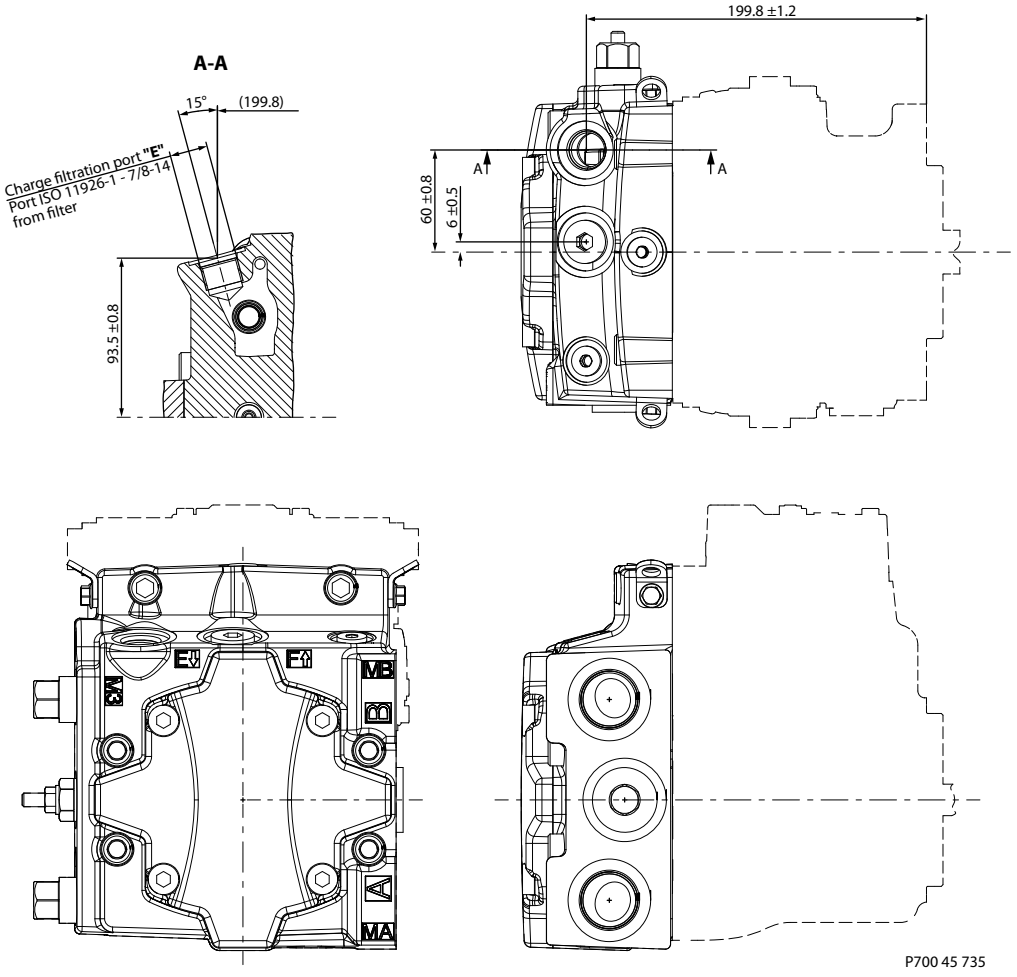
Please contact Sauer-Danfoss for specific installation drawings

Installation Drawings (continued)

Filtration

mm

*External full flow charge pressure filtration, option **E***



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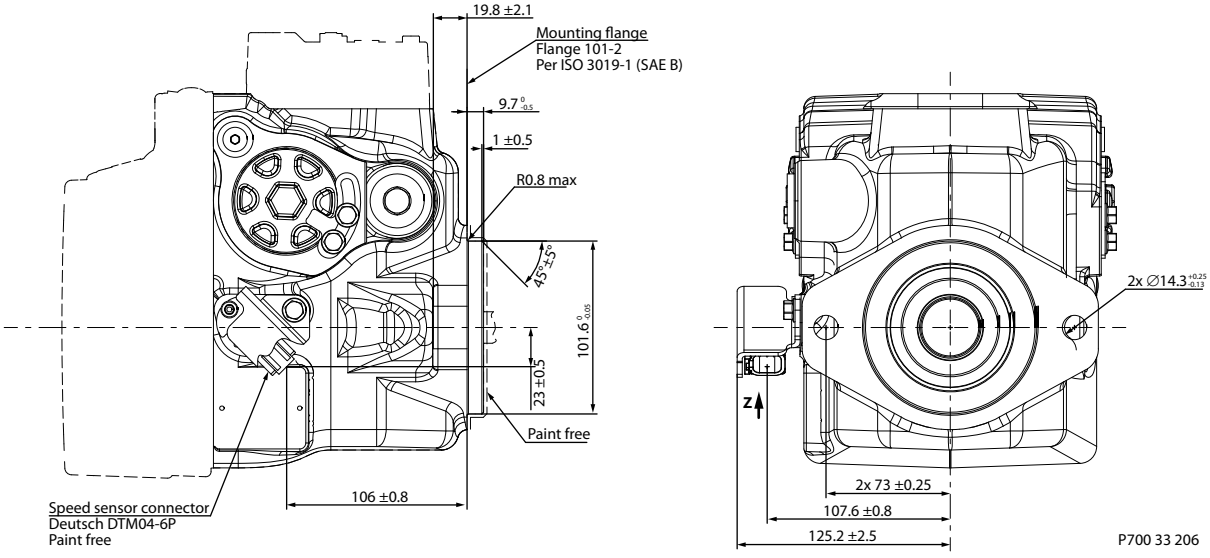
Installation Drawings (continued)

Speed and Temperature Sensor

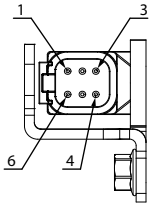
mm

*Speed and Temperature Sensor, option **H** for mounting flange option **K***



Speed sensor Connector	
PIN	ASSIGNMENT
1	Output signal 2
2	Direction
3	Output signal 1
4	Supply
5	Ground
6	Temperature

Z (2:1)



P301 310

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